CRM 95-209 / February 1996

Setting Priorities for Graduate Medical Education

Neil B. Carey • Marjorie D. Curia • Oliver A. Smith

19960718 027

DTIC QUALITY INSPECTED 3

Center for Naval Analyses
4401 Ford Avenue • Alexandria, Virginia 22302-1498

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

Approved for distribution: February 1996

Lauria J. May

Laurie J. May, Director
Medical Team
Support Planning and Management Division

This document represents the best opinion of CNA at the time of issue.
It does not necessarily represent the opinion of the Department of the Navy.

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED
For copies of this document, call the CNA Document Control and Distribution Section (703) 824-2130

REPORT DOCUMENTATION PAGE

Form Approved
OPM No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources gathering and maintaining the data needed, and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503.

1. AGENCY USE ONLY *(Leave Blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	February 1996	Final

4. TITLE AND SUBTITLE	5. FUNDING NUMBERS
Setting Priorities for Graduate Medical Education	C - N00014-91-C-0002 PE - 65154N PR - R0148
6. AUTHOR(S) Neil B. Carey, Marjorie D. Curia, Oliver A. Smith	

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
Center for Naval Analyses 4401 Ford Avenue Alexandria, Virginia 22302-0268	CRM 95-209
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Assistant Chief for Plans, Analysis, and Evaluation, MED-08	10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE
CLEARED FOR PUBLIC RELEASE	

13. ABSTRACT *(Maximum 200 words)*

The Navy's Graduate Medical Education (GME) program consists of post-medical school programs to train physicians. These programs have been successful in improving the quality and dependability of sources of medical corps personnel. In recent years, the Navy has downsized GME somewhat. Further reductions in GME may be mandated because of budget constraints, but Medical Operational Support Requirements—which support the Marine Corps, ships afloat, and Navy bases outside the continental United States—may require some specialty programs to enlarge. Therefore, the Surgeon General of the Navy, via the Assistant Chief for Plans, Analysis, and Evaluation, asked CNA to study past medical corps attrition and build a model to assist with the planning of GME program size. This research memorandum addresses how the Navy can set priorities among its GME programs, a subject currently under study by staffs working for the Chief, Medical Corps, the Assistant Chief for Personnel Management, the Assistant Chief for Plans, Analysis, and Evaluation, and the former Health Services Education and Training command. This memorandum is intended to assist the work of these staffs.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Attrition, data bases, education, mathematical models, medical personnel, military medicine, naval personnel, naval training, personnel retention, physicians, reduction	82
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	SAR

NSN 7540-01-280-5500

Standard Form 298, (Rev. 2-89)
Prescribed by ANSI Std. 239-18
299-01

Contents

Summary

Objective

The Navy's graduate medical education (GME) program consists of post-medical school programs to train physicians. These programs have been successful in improving the quality and dependability of sources of medical corps personnel. In recent years, the Navy has downsized GME somewhat. Further reductions in GME may be mandated because of budget constraints, but Medical Operational Support Requirements—which support the Marine Corps, ships afloat, and Navy bases outside the continental United States—may require some specialty programs to enlarge. Therefore, the Surgeon General of the Navy, via the Assistant Chief for Plans, Analysis, and Evaluation, asked CNA to study past medical corps attrition and build a model to assist with the planning of GME program size.

This research memorandum addresses how the Navy can set priorities among its GME programs, a subject currently under study by staffs working for the Chief, Medical Corps (MED-OOMC), the Assistant Chief for Personnel Management (MED-05), the Assistant Chief for Plans, Analysis, and Evaluation (MED-08), and the former Health Services Education and Training Command (HSETC). This memorandum is intended to assist the work of these staffs. It addresses the issue of GME priorities by answering the following questions:

- In which specialties does being trained in in-house GME most improve retention?
- In which specialties are attrition rates the highest?
- Which specialties might need more senior-level medical corps officers?
- In which specialties will it be most difficult to recruit?

Phase 1

In phase 1, we addressed the first three questions by using a longitudinal database that we developed from Bureau of Medicine Information System (BUMIS) files for fiscal years 1990 through 1994, and from a historical database covering 1983 through 1989. In this phase, we also addressed the fourth question by analyzing published projections of U.S. physician specialty shortages and surpluses.

Later in this document, we summarize the findings from the descriptive analyses we performed in phase 1. We indicate the extent to which training in a Navy residency improves retention, compared to the retention of those trained in civilian residencies. We found that medical corps in the fields of anesthesiology and family practice who received training in in-house Navy residencies remain in the Navy at a much higher rate than do those who were trained in civilian residencies. Retention is better for Navy residencies in anesthesiology and family practice than in other specialties.

Another goal of Navy medicine is to be able to replace physicians who leave. By this reasoning, the Navy should retain GME programs in specialties that have the highest attrition rates. In ranking the specialties that leave the Navy at the highest rates, we found that anesthesiology, orthopedics, and ear, nose, and throat (ENT) have consistently high attrition rates. This consideration suggests that the Navy should give high priority to those three specialty programs.

Navy medicine also needs a sufficiently experienced force of physicians to serve as leaders and mentors for newly trained medical corps. In our summary of phase 1 results, we indicate which specialties have a particularly high percentage (>=70 percent) of junior officers. By this criterion, anesthesiology, orthopedics, emergency medicine, and obstetrics/gynecology (OB/GYN) should have high priority as GME programs.

Ideally, Navy medicine would retain programs for which there is a projected shortage in the civilian sector because those specialties will be more difficult to recruit and retain. We found that emergency medicine, psychiatry, and anesthesiology are predicted to be in short supply. However, the supply/demand picture changes too rapidly to be sure that these predictions are correct.

Overall, phase 1 of our research indicates a priority for GME programs. One weighting scheme for phase 1 indicators is to give equal weight to each one. Giving *equal weight* to the five indicators we chose, anesthesiology, orthopedics, and emergency medicine should be high-priority programs in Navy GME. By way of contrast, radiology, ophthalmology, and pediatrics should have lower priority.

Phase 2

The methods used in phase 1 do not account for the interacting effects of accession rates, retention rates, length of residencies, and obligation policies. They cannot, by themselves, project the size of medical corps specialties given alternative assumptions about the future.

To clarify the many interacting complexities and uncertainties involved in sizing GME programs, we developed a model in phase 2. This Medical Corps Community Model projects the future size of medical corps specialties, given the user's inputs for attrition rates, accession rates, and selected policy variables. The model can show future projections against the standards of Medical Operational Support Requirements (MOSR) and 1994 authorized billets. Also, the model's projections provide policy indicators, such as the percentage of total medical corps personnel receiving residency training and the percentage of residency trainees in Navy GME programs. This memorandum shows examples of some of the kinds of analyses that the model can support:

- Given the model's default rates of accessions, specialty choice, and attrition, how would the numbers of medical corps personnel in 2005 compare with MOSR requirements and 1994 authorized billets? (scenario 1)
- If medical corps retention deteriorated to the levels of the late 1980s, what would be the major areas of shortfall? (scenario 2)
- If the Navy recruited 60 Financial Aid Program (FAP) participants per year, to what extent could the additional recruits compensate for an attrition rate like that of the late 1980s? (scenario 3)

Conclusion

The analyses presented and model developed for this project can provide useful input into decision-making regarding the size of GME programs. Our findings from phase 1 indicate the relative importance of GME programs, given several straightforward force management criteria, but they are not definitive. The model from phase 2 supplies additional information, and allows decision-makers to see the consequences of changing relevant variables. However, neither phase of this research accounts for important nonquantitative considerations, such as the substitutability of physicians from different specialties. For these reasons, the judgments of experienced medical personnel and community managers[1] must be included in making final decisions. When quantifiable considerations are combined with the clinical judgment and experience of BUMED personnel, better decisions can be made concerning the size of GME programs.

1. We use the term "community manager" informally to refer to all those personnel responsible for some aspect of the medical corps. There are many Navy codes that bear responsibility for the medical corps, but, to our knowledge, only BUPERS 211M has the formal title of community manager.

Background

Reasons for GME

The Navy's graduate medical education (GME) program consists of post-medical school programs that train physicians. These residency and fellowship programs[2] account for about 1,000, or 25 percent, of the Navy's medical corps billets; they have trained most of the active duty physicians who work in the Navy's health care system.

Military GME was initially a response to concerns about the quality of military medicine across the uniformed services [1, 2], and it has been successful in improving the quality and dependability of sources of medical personnel [3]. Several groups that have studied military GME have supported the importance and uniqueness of its mission [4, 5]. Some of the reasons given for GME follow:

- GME provides an emergency source of military-committed physicians in the event of contingencies or war, and a method of preventing military medicine from becoming isolated from civilian medicine [1, 3].
- GME provides an opportunity for the military to develop and maintain the required skill mix of its medical providers.
- GME develops physicians who stay in the service longer than physicians from other sources, providing leadership and a stable core of career medical personnel [6, 7].
- GME residents furnish 24-hour access to medical care that would be expensive to replace with fully trained physicians.[3]

2. Residency programs are entered after internship has been completed. In contrast, fellowships provide more advanced training past residency.
3. For example, New York and California have found it expensive to replace residents' work [8, 9].

- It offers military-specific training for general medical officers, flight surgery, and undersea medicine that is not available in the civilian sector.
- It provides a way for the military to get physicians when there is a shortage in the civilian sector because the opportunity to teach in a GME program improves recruiting. As recently as the late 1980s, Navy medicine faced a shortage of physicians [10, 11, 12, 13]; without GME, the shortage would likely have been considerably worse.

The problem we addressed

Despite the many benefits of GME, the 1990s will see changes to the size of GME programs. The Navy and other services are already implementing a plan to cut their fellowships [14], and consolidations of GME programs are being implemented where more than one service has a training program in the same geographical area: for example, Walter Reed (Army) and Bethesda Naval Hospital have merged their neonatal care units [15]. Further cuts to military medicine are anticipated [16], making it necessary for Navy medicine to consider further possible reductions in GME.

Although adjustments might be needed, GME must still be large enough to support the Navy's Medical Operational Support Requirements (MOSR) [17]. Reference [17] provides a detailed formal definition of MOSR requirements. These requirements provide minimum numbers of physicians and other health care providers for (1) wartime missions, such as hospital ships and fleet hospitals, and (2) day-to-day operational support for the fleet, the Fleet Marine Force, and facilities outside the continental United States (OCONUS). On average, about 30 percent of Navy medicine is deployed or working in OCONUS facilities at any given time [17]. In addition to these requirements, there must be a rotation base that provides personnel to refill these billets when they are vacated [18]. Table 1 summarizes the Navy's largest medical corps MOSR requirements by specialty.[4]

4. The MOSR requirements listed in table 1 were obtained in October 1995. They are subject to change, depending on new circumstances and priorities for Navy medicine. MOSR is *not* Navy medicine's only priority; Navy medicine also has responsibility for treating Navy dependents who seek treatment in its CONUS facilities.

Analyses of MOSR requirements could, conceivably, result in requirementsw for a larger GME program in one or two specialties.[5]

Table 1. Navy's largest Medical Operational Support Requirements (MOSR)

Navy officer billet code	Primary subspecialty	Specialty name	MOSR
0101	16RO	General internal medicine	109
0101	16R1	Internal medicine subspecialty	102
0102	15FO	General medical officer	297
0105	16VO	General pediatrics	60
0105	16V1	Pediatric subspecialty	22
0107	16UO	Undersea medicine	80
0108	16QO	Family practice	262
0109	16PO	Emergency medicine	113
0110	15AO	Aviation medicine	254
0110	15A1	Aerospace medicine	29
0111	16NO	Dermatology	21
0115	16XO	General psychiatry	76
0118	15BO	Anesthesiology	199
0121	16TO	Neurology	15
0131	16YO	Radiology	47
0150	15MO	General pathology	30
0160	15KO	Preventive medicine	26
0163	15K1	Preventive medicine subspecialty	11
0166	15K2	Occupational medicine	10
0214	15CO	General surgery	191
0214	15C1	Surgical subspecialty	29
0224	15DO	Neurosurgery	21
0229	15EO	OB/GYN	79
0234	15GO	Ophthalmology	19
0244	15HO	Orthopedics	143
0249	15IO	ENT	29
0254	15C1	Plastic surgery	8
0259	15C1	Colorectal surgery	8
0264	15C1	Cardiothoracic surgery	8
0269	15JO	Urology	33

5. For example, calculations from N-931 indicate that orthopedics and anesthesiology might be examples of specialties that need to enlarge in order to fill MOSR requirements.

All these factors are considerations in setting priorities for graduate medical education. CNA performed this research in support of several BUMED codes. We prepared this document to assist in deciding which GME specialties should be given highest priority to expand or retain at present size. It provides analyses that supplement those regularly performed by BUMED staff members [19, 20].

This CNA effort supplements these BUMED projects as follows:

- It considers obligation status when computing attrition rates. Typically, efforts to project force size have relied on continuation rates by specialty. Continuation rates are based on total personnel, regardless of obligation status, and are not very sensitive to emerging changes in attrition rates. Unobligated attrition rates, particularly end-of-initial-obligation attrition rates, are more sensitive to changes in the overall market than are continuation rates. For example, the physician retention problem of the mid- to late-1980s was apparent only when unobligated attrition patterns were considered; continuation rates during that time were quite stable.
- It determines in which specialties the medical corps might need more senior personnel, based on analyses of experience distributions.
- It projects surpluses and shortages of physicians.
- It develops a computerized model to assess the impact of likely future rates of attrition and accession on the size and composition of the medical corps.

Overview of this research

This research memorandum provides information for the Navy's process of setting priorities for graduate medical education.[6] We do this by answering the following questions:

6. Any final decisions about the enlarging or downsizing of GME programs clearly require input from clinical practitioners. Therefore, this memorandum is written to provide information, not to make specific recommendations regarding the size of particular specialty programs.

- In which specialties is the difference between retention in deferred GME and in-house GME the largest? Those GME programs with larger differences might be more valuable to the Navy because of their positive effect on retention.
- In which specialties are attrition rates highest?
- In which specialties is the medical corps possibly in need of more senior-level officers?
- Given current projections, which specialties should be easier to recruit as the 1990s draw to a close?
- Assuming current rates of recruiting and attrition, for which specialties is the Navy most in danger of experiencing shortages or surpluses?
- How would changes in GME policy affect the future size and composition of the medical corps?

This research memorandum presents a model of Navy physician supply that can be used to predict future Navy GME accession needs. We developed a working computer implementation of this model as part of this effort. After describing some background and our methodology, the rest of this memorandum presents our findings and describes the capabilities of the model we have developed.

Planned changes in military GME

Our analyses of Navy GME should be viewed in light of planned and recently executed changes to the services' programs. The services have been making cuts to their GME programs over the last few years, and current plans are for about 500 positions to be cut, across the services, between 1990 and 1999 (see table 2). Most planned program cuts are to fellowships, rather than to residencies [14]. Base Realignment and Closure (BRAC) cuts are responsible for the only facilities that will close (e.g., Naval Hospital, Oakland). Further details are available in a *U.S. Medicine* article [14]. Most of the planned cuts will result from two principles in reducing GME:

- GME programs with no input for FY 1994 and FY 1995 will be phased out through 1998.

- Duplicate GME programs in the National Capital Region (Washington, DC) and San Antonio, TX, will be integrated.

Table 2. Recent and planned cuts in military GME, 1990–1999 [14]

	Year of cuts		
GME area	1990–1994	1995–1999	Total
Facilities	3	2	5
Programs	17	65	82
Trainees	238	264	502

The six accession sources of physicians

To project the size of the future medical corps, and the demand for GME, we need to know how physicians are accessed into the Navy. These accession sources provide the medical corps' inputs. Furthermore, each accession source has different obligation rules and historical rates of attrition.

Most physicians enter the services through the Health Professions Scholarship Program (HPSP). HPSP provides medical students with tuition, a stipend, and other expenses related to medical school. By accepting this scholarship, medical students agree to serve as physicians in the Navy 1 year for every year they receive the scholarship, with a 3-year minimum. At the end of medical school, these students usually enter active duty service at the O-3 paygrade.

The most common path after entering active duty is to serve internship and professional residency training in Department of Defense (DOD) medical centers, such as Naval Hospital, Bethesda, or Naval Hospital, San Diego. This path is called *in-house GME*, or *full-time in-service* (*FTIS*). In the past, residency training incurred a year-for-year obligation that could be served concurrently with initial HPSP obligation. However, the new rule, implemented in 1988, is that you cannot serve medical school obligations while in a residency program. Table 3 provides examples of obligations under the old rules and the new rules.

Table 3. Examples of obligation rules before and after April 1988[a]

Before April 1988		After April 1988	
Source	Effect on obligation	Source	Effect on obligation
	Example 1		
3-year scholarship	+3 MSR	3-year scholarship	Same as before
Navy intern	+0	Navy intern	Same as before
General medical officer (GMO) (2 years)	-2	GMO (2 years)	Same as before
Navy GME (4 years)	+0	Navy GME (4 years)	+4 (+2 served together)
Obligated service date	2 years past GME	Obligated service date	4 years past GME
	Example 2		
4-year scholarship	+4	4-year scholarship	+4
Navy intern	+0	Navy intern	+0
GMO (2 years)	-2	GMO (2 years)	-2
Navy GME (4 years)	+0	Navy GME (4 years)	+4
Obligated service date	2 years past GME	Obligated service date	4 years past GME

a. Before April 1988, in-house GME was obligation neutral, but there was a 2-year minimum service requirement (MSR) upon completion/termination; afterward, in-house GME incurred a year-for-year obligation (served concurrently with HPSP obligation) [21].

Another path is called *deferred HPSP*. With the approval of the Navy, these scholarship physicians defer their active duty until completing their internship or residency at a civilian teaching facility. This does not affect their service obligation, and they enter active duty at the paygrade they would have attained if they stayed in nondeferred HPSP. These medical corps personnel are also called Navy Active Duty Delay for Specialists (NADDS).

Another path is called *full-time out-service (FTOS)*. With approval of the Navy, an active duty officer may attend residency in a civilian facility. The difference between NADDS and FTOS is that, in FTOS, the officer remains on active duty. FTOS physicians have often served duty tours as general medical officers (GMOs) before becoming FTOSs.

Direct accessions, also called volunteers, are residency-trained graduates of medical schools who have not received HPSP. These physicians enter active duty at a level between O-3 and O-6, depending on their

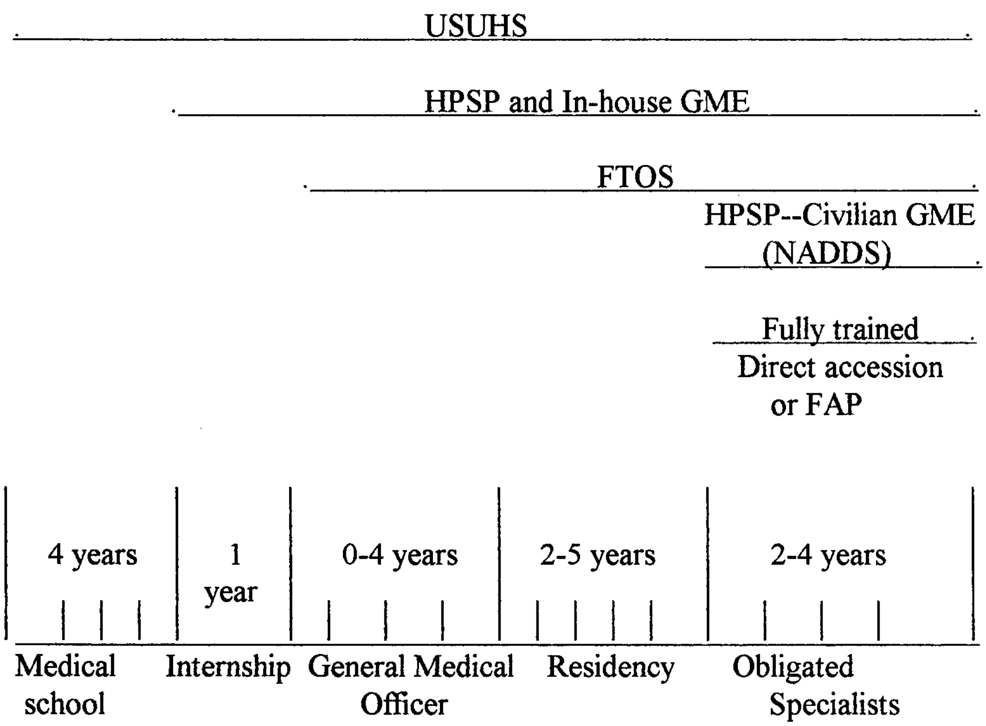
training and experience. They become obligated to serve for at least 3 years.

Students at the *Uniformed Services University of the Health Sciences (USUHS)* enter active duty at the beginning of medical school at the grade of O-1. When they graduate, they become O-3s with an obligation of 7 years, and are paid at the same rate as other new physicians in the military. Time at USUHS does not earn pay credit, nor does it count toward 20-year retirement eligibility. However, once a physician has 20 years of active duty, the years at USUHS do contribute to the amount of retirement pay.

In 1990, a new path opened—the *Financial Aid Program (FAP).* In this program, residents from any civilian institution can receive a grant of over $25,000 per year and a monthly stipend. For this assistance, FAP participants incur a one-for-one service obligation, with a minimum of 3 years. After residency, they enter active duty at the same paygrade as do other physician accessions. The rationale for the program is that the services know the physician's specialty, and the military avoids paying tuition or salary costs during medical school or internship. However, students from USUHS or HPSP can also participate in the FAP, incurring further military obligation. So far, the Air Force has had much more success recruiting via FAP than has the Navy. It remains to be seen whether FAP can provide the Navy with a significant number of recruits.

Figure 1 shows when each accession source begins active duty in the Navy. Active duty starts at the beginning of medical school for USUHS accessions. In contrast, active duty begins at the end of medical school, beginning of internship, for HPSP accessions. For HPSPs who go through civilian GME (NADDS), active duty begins after residency, when the physician has become a fully trained specialist. Direct accessions also begin their Navy career fully trained. On occasion, a direct accession will enter the Navy and begin training in a new specialty, accruing more obligation as a result of the Navy residency training received.

Figure 1. Career paths of Navy physicians (modified from [22]



Phase 1: Describing physician communities

Overview

This research consists of two phases. Each had a different set of goals and a distinct research method. We describe phase 1 here.

This phase of the research deals with analyses that will help community managers to fulfill goals of (1) having a dependable supply of long-term career physicians and (2) having a sufficient number of physicians with over 5 years' experience in each specialty. If the goal of medical corps community managers is to provide a dependable supply of long-term career physicians, then attrition is a critical factor in planning. Because there is a higher retention rate for physicians who receive residency training in GME, GME helps fulfill the goal of having a dependable supply of physicians. Furthermore, attrition is a critical component of predictions of how many medical corps will be needed.

A second goal of community management is to have enough medical corps with experience (e.g., more than 5 years[7]) past residency. This criterion of "medical corps community health" emphasizes the fact that physicians in the early part of their careers can benefit from having more experienced physicians as leaders and consultants. For this second goal, the criterion of what percentage of the community has more than 5 years' experience is important.

A third goal of community managers is to use the lowest-cost accession sources, if they are dependable and produce recruits of high quality. Usually, direct accessions cost less than HPSP or USUHS accessions because the Navy does not pay for the cost of medical school or residency training [24]. The FAP and NADDS are also less expensive than USUHS because the Navy does not pay for medical

7. Although the choice of 5 years is somewhat arbitrary, it has been used in earlier studies [10–13].

school of FAP participants, and the Navy does not pay for active duty salary during NADDS' residencies.

A major determinant of the Navy's probable success in recruiting direct accessions and FAP participants is the relative surplus or shortage of U.S. physicians in particular specialties. Therefore, the final portion of phase 1 of this research reports our findings regarding projected surplus or shortage of physicians.

Method: Descriptive analysis

For the first phase, we built a longitudinal database of medical corps careers for 1990 through 1994. The database provided an analytic tool for computing a number of different attrition rates. One important attrition rate is simply *overall attrition*: What percentage of those medical corps who began the fiscal year were still on active duty at the end of the fiscal year? A second important attrition rate is *at the end of initial obligation*. This attrition rate is important because it is often more sensitive to changes in the outside job market for physicians than is overall attrition, which incorporates a majority of physicians who are still under an obligation (and therefore cannot leave the Navy) and those who have stayed past the end of initial obligation (and therefore have most likely made a decision to stay in the Navy until retirement).

For the first phase of this research, we ranked each specialty by its importance according to such indicators as:

- Overall attrition rate
- Attrition rate at end of initial obligation
- Percentage of specialty that has less than 5 years' experience
- Difference in attrition rate between those who attended in-house GME and those who had deferred GME.

For each of these indicators, larger values indicate that the specialty is more important for retaining the size of the GME program. High overall or end-of-initial-obligation attrition rates indicate that a need for more physicians of that specialty will continue. A higher percentage of specialty with less than 5 years' experience indicates that the

specialty is having trouble retaining physicians who have been in the Navy long enough to be leaders and mentors to new physicians entering the Navy. And a large difference between the attrition rate of in-house GME vs. deferred GME indicates that, in that particular specialty, having gone through in-house GME appears to have a large effect on later retention.

Although this first phase of the research can provide guidance concerning which programs should retain their size, by itself, it is incomplete. We need a method of combining the data from these different indicators to supply an overall ranking of importance. One way to do this—the method we adopted—is to rank each specialty by its position on an indicator, for example, awarding the smallest number (1) to the specialty with the highest attrition, and the largest rank to the specialty with the lowest attrition. Then, the specialties with the lowest average number of "points" would be retained in GME, and those with the highest average rank would be more vulnerable to cutbacks.

For our work on attrition rates, the major contribution we have made is to differentiate initial obligation attrition from other kinds of attrition. Therefore, the following section explains how we approximated who was ending initial obligation for the computation of the attrition rates that we present in the results section.

Defining initial obligation

The quickest way for physicians entering the Navy to meet their accession obligation is to complete an internship and serve as a general medical officer (GMO) for the length of the obligation [22]. However, specializing through at least one formal residency program is the normal career path. In the 1980s, approximately 66 percent of scholarship and 82 percent of direct accessions completed at least one residency program [22].[8] Therefore, we adopted the separate definitions of initial obligation for specialists and GMOs used in earlier CNA research [22]. First, the initial obligation for a GMO is

8. The 82-percent figure includes direct accessions who had completed at least one residency program before coming into the Navy. We are *not* saying that 82 percent of direct accessions get residency training once they enter the Navy.

defined as the obligation a physician incurs for an accession program. In contrast, the initial obligation for a physician who completes at least one residency is defined as a physician's first opportunity to leave the Navy as a trained specialist.

Specializing usually postpones the physician's first opportunity to leave the Navy. But our definition assumes that the decision to specialize is a professional matter rather than an indication of preference to stay in the Navy. Because 80 percent of doctors who have second residencies have a second residency in the same specialty as their first residency (i.e., a fellowship for further subspecializing, reference [22], we treat obligation for a second residency that closely follows completion of the first residency as part of the initial obligation.

We treat obligation for direct accessions differently than we treat obligation for scholarship physicians. For direct accessions who begin active duty as specialists, the initial obligation is the contract obligation—usually 3 years.

Using the BUMIS database

Because it takes a great deal of information to identify the end of an initial obligation, we made a longitudinal database from the Bureau of Medicine Information System (BUMIS), using the final file from each fiscal year from 1990 to 1994. As a supplement, we used a longitudinal database from 1983 to 1989 that was created for earlier CNA projects [10, 13, 22]. An earlier CNA study [10] identified BUMIS as the best database for medical corps issues because of its accuracy in providing specialty codes.

Unfortunately, BUMIS does not directly contain the length of initial obligation. It does contain an obligated service date (OSD)—the date on which the physician's most recent period of obligated service ends. However, a physician's OSD ultimately might not be the end of initial obligation because the physician might begin a residency that extends an initial obligation.[9] Therefore, we counted closely following residencies as consecutive residencies, part of the initial obligation.

9. Also, a physician who has passed the initial obligation might augment, which also extends the obligation. Augmenting is a signal that the person is intending to stay in the Navy.

To calculate the end of initial obligation for specialists, we use separate definitions for:

- In-house-trained HPSP accessions
- Civilian-trained direct and deferred HPSP accessions
- In-house-trained direct accessions.

Our working definition of initial obligation for HPSP accessions is an obligation that ends within two to four years of the most recently completed residency. Our definition for direct accessions, if fully-trained, and deferred HPSP accessions, is when the physician reaches the end of initial obligation within three years of beginning active duty. If a direct accession begins residency training immediately upon entering the Navy, the physician reaches the end of initial obligation within three years of the last consecutive residency.

Results

In which specialties does GME most improve retention?

One factor to consider in setting priorities is the effect GME has on retention. It is well known that, on average, those trained in in-house GME programs stay in the Navy longer than those trained in civilian facilities [24]. During 1990 through 1994, the attrition rate at the end of initial obligation for deferred GME participants was 66 percent, but only 50 percent for those trained in-house.

To look at attrition rates by specialty, we find we must pool the data over time to get a sufficient number of cases.[10] Pooling data from the 1980s with those of the 1990s gives a larger number of cases ending their initial obligation to compare the attrition rates of deferred HPSP and in-house GME. Therefore, table 4 compares the cumulative attrition rates of *eligible* specialists from 1983 to 1994.

---

10. Confidence limits can be set for attrition rates using the standard **z** value multiplied by $[(\mathbf{p}(1 - \mathbf{p})/\mathbf{n})]^{1/2}$, where **p** is the attrition rate and **n** is the size of the sample at the beginning of the year. Detailers anecdotally report that attrition and recruitment rates have changed in the last 1 to 2 years. The small number of cases per year makes it questionable whether these new rates reflect a trend or merely random fluctuations.

Table 4. Initial unobligated attrition rates—deferred vs. in-house GME,[a] 1983–1994

Specialty name	Average attrition: Deferred GME	Average attrition: In-house GME	Number of cases: Deferred	Number of cases: In-house
Aerospace medicine	0.00[b]	0.00[b]	5	5
Anatomy/clinical pathology	0.40[b]	0.24[b]	10	21
Anesthesiology[c]	0.95	0.65	56	96
Dermatology	0.33[b]	0.50	6	32
Diagnostic radiology	0.66[b]	0.69	29	77
Emergency medicine	0.64[b]	0.43	14	30
Family practice[c]	0.67	0.39	43	246
General surgery	0.62	0.73	42	56
Internal medicine	0.71	0.51	66	65
Neurology	0.82[b]	0.93[b]	11	14
Neurosurgery	0.67[b]	1.00[b]	9	3
OB/GYN	0.56[b]	0.71	25	76
Ophthalmology	0.63[b]	0.41	8	39
Orthopedic surgery	0.88	0.73	32	62
Otolaryngology	0.50[b]	0.66	8	41
Pediatrics	0.65	0.55	40	62
Plastic surgery	0.75[b]	0.75[b]	4	4
Psychiatry	0.50[b]	0.35	24	48
Thoracic surgery	0.33[b]	0.33[b]	3	3
Urology	0.25[b]	0.61	8	33

a. This table excludes direct accessions, comparing only HPSP in-house vs. deferred.
b. Attrition rate might be volatile due to small sample size.
c. The difference between the attrition rate for deferred vs. in-house GME is statistically significant.

Attrition rates for specialties with fewer than 30 personnel are unstable and could be misleading. Among specialties that have over 30 cases in both groups, **anesthesiology** has the largest "payoff" in terms of added retention among those trained in-house versus in civilian residencies (with a difference of .95 to .65, or 30 percent in retention at end of obligation). **Family practice**, with a difference of 28 percent, also shows large differences between the retention behavior of medical corps from in-house versus deferred residencies. The large differences for these two specialties indicates that having in-house GME is particularly helpful for fulfilling Navy needs for these types of physicians. Other differences in the table are not statistically significant,

using confidence limits for difference in proportion [25]. Note that all statistically significant differences show that GME increases retention.

In which specialties are attrition rates the highest?

Tables 5, 6, and 7 show the attrition patterns for the early 1990s. Table 5 gives the overall attrition of physicians, both obligated and unobligated. It shows that, from 1990 to 1993, the highest attrition rates[11] were for obstetrics/gynecology, otolaryngology/head and neck surgery, plastic surgery, and anesthesiology.

Table 5 shows overall attrition patterns, also called continuation patterns, which are not very sensitive to emerging changes in attrition rates. Unobligated attrition rates, particularly at the end of initial obligation, are more sensitive to changes in the overall market than are continuation patterns. Therefore, table 6 shows the attrition rates at end of initial obligation, 1990 to 1993. (Appendix B shows the same rates, but for a larger number of specialties.) Table 6 shows that orthopedic surgery, general surgery, and anesthesiology have the highest rate of attrition at end of initial obligation. The higher attrition rates indicate that these specialties should be given priority in GME. Taken together, tables 4 through 6 suggest that orthopedic surgery, otolaryngology/head and neck surgery, and anesthesiology are specialties that benefit the most from GME in order to meet the Navy's needs.

11. The rates in table 5 will not match those in Med-0512's "World Book"; the World Book includes changes in specialty as attrition, whereas table 5 does not. Appendix A provides attrition rates from a larger number of specialties.

Table 5. Trends in fully trained attrition rates, 1990-1993, obligated and unobligated[a]

Medical corps specialty name	1990		1991		1992		1993		1990-1993	
	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis
Aerospace medicine	0.03	35	0.03	40	0.13	40	0.03	37	0.05	152
Anatomy/clinical pathology	0.08	80	0.15	82	0.16	75	0.07	71	0.11	308
Anesthesiology	0.21	141	0.20	160	0.16	174	0.20	182	0.19	657
Colon and rectal surgery	0.00	4	0.13	8	0.17	6	0.00	6	0.08	24
Dermatology	0.23	35	0.12	33	0.13	45	0.10	50	0.14	163
Diagnostic radiology	0.18	92	0.22	98	0.19	94	0.20	97	0.20	381
Emergency medicine	0.18	44	0.24	51	0.13	55	0.18	67	0.18	217
Family practice	0.10	239	0.15	266	0.15	251	0.12	257	0.13	1,013
Flight surgery—(aviation medicine)	0.10	246	0.13	269	0.14	290	0.16	303	0.13	1,108
General surgery	0.10	157	0.15	164	0.12	169	0.15	163	0.13	653
General medical officer	0.08	501	0.16	582	0.16	508	0.15	559	0.14	2,150
Internal medicine	0.17	127	0.16	122	0.15	115	0.16	110	0.16	474
Neurology	0.20	25	0.25	20	0.05	21	0.08	24	0.14	90
Neurosurgery	0.15	20	0.18	17	0.31	16	0.24	17	0.21	70
Obstetrics/gynecology	0.26	95	0.30	86	0.22	77	0.16	86	0.24	344
Occupational health	0.03	36	0.09	47	0.11	45	0.11	35	0.09	163
Ophthalmology	0.18	50	0.17	47	0.20	45	0.13	45	0.17	187
Orthopedic surgery	0.16	86	0.20	100	0.21	102	0.30	105	0.22	393
Otolaryngology/H&N surgery	0.21	53	0.22	51	0.20	51	0.27	56	0.22	211
Pediatrics	0.12	137	0.11	135	0.11	127	0.18	130	0.13	529
Plastic surgery	0.31	13	0.27	11	0.20	10	0.00	9	0.21	43
Preventive medicine	0.19	27	0.03	29	0.03	31	0.14	37	0.10	124
Psychiatry	0.05	100	0.07	109	0.10	118	0.15	120	0.10	447
Thoracic surgery	0.25	4	0.20	5	0.00	8	0.09	11	0.11	28
Undersea medicine	0.07	88	0.14	95	0.12	101	0.17	93	0.12	377
Urology	0.18	38	0.08	40	0.23	39	0.30	37	0.19	154
Overall attrition rate	0.12		0.15		0.14		0.16			
Number on which rate is based (basis)		2,782		3,029		2,985		3,124		11,920

a. Attrition rates refer to leaving the Navy. These rates do not count transfers as attrition.

Table 6. Attrition at end of obligation, HPSP and direct accessions, 1990–1993

Specialty name	Basis	Number leaving within 1 year	1-year attrition rate	Rank (of those with basis >30)
Aerospace medicine	16[a]	2	0.13	—
Anatomy/clinical pathology	55	17	0.31	10
Anesthesiology	109	70	0.64	4
Colon and rectal surgery	0	0	NA	—
Dermatology	41	10	0.24	11
Diagnostic radiology	58	28	0.48	6
Emergency medicine	53	18	0.34	9
Family practice	238	73	0.31	10
Flight surgery (aviation medicine)	292	98	0.34	9
General surgery	62	41	0.66	3
GMO	334	116	0.35	8
Internal medicine	87	44	0.51	5
Neurology	15[a]	15	1.00	—
Neurosurgery	8[a]	7	0.88	—
Obstetrics/gynecology	23[a]	19	0.83	—
Occupational health	35	11	0.31	10
Ophthalmology	23[a]	8	0.35	—
Orthopedic surgery	46	38	0.83	1
Otolaryngology/ H&N surgery	46	27	0.59	5
Pediatrics	62	23	0.37	7
Physical medicine and rehabilitation	7[a]	0	0.00	—
Plastic surgery	9[a]	3	0.33	—
Preventive medicine	18[a]	4	0.22	
Psychiatry	48	15	0.31	10
Thoracic surgery	0	0	NA	—
Undersea medicine	33	22	0.67	2
Urology	29[a]	17	0.59	—
Total	2,130	877	0.41	—
Table total	1,599	726	0.45	—

a. Attrition rate might be volatile because of small sample size (<30).

Table 7. Trend of percentage of medical corps with 1 to 5 years' experience, 1983–1994

Specialty	FY 1983 %	FY 1983 Basis	FY 1987 %	FY 1987 Basis	FY 1990 %	FY 1990 Basis	FY 1994 %	FY 1994 Basis
Aerospace	9	(22)	38	(13)	52	(33)	51	(41)
Anesthesiology	62	(86)	81	(110)	74	(141)	70	(167)
Dermatology	50	(34)	65	(37)	51	(35)	64	(53)
Emergency medicine	75	(12)	88	(24)	70	(40)	72	(71)
Family practice	74	(199)	78	(179)	68	(230)	60	(243)
General surgery	40	(114)	54	(108)	49	(156)	55	(150)
Internal—general	58	(146)	76	(141)	59	(125)	54	(120)
Cardiology	41	(34)	50	(26)	33	(24)	35	(20)
Internal—other	36	(121)	35	(91)	32	(108)	26	(119)
Neurology	46	(24)	44	(25)	56	(25)	42	(26)
Neurosurgery	67	(12)	64	(11)	75	(20)	82	(17)
OB/GYN	53	(128)	64	(105)	64	(95)	73	(90)
Ophthalmology	58	(55)	53	49	(64)	50	56	(45)
Orthopedics	55	(69)	78	(93)	74	(86)	73	(89)
Otolaryngology	51	(43)	60	(42)	53	(53)	65	(55)
Pathology	54	(85)	47	(73)	40	(80)	44	(73)
Pediatrics	45	(206)	47	(172)	47	(137)	50	(117)
Plastic surgery	43	(7)	46	(13)	8	(13)	50	(12)
Preventive medicine	38	(26)	53	(25)	58	(26)	45	(29)
Psychiatry	39	(101)	40	(83)	39	(100)	44	(111)
Radiology	56	(102)	55	(91)	52	(91)	58	(91)
Thoracic surgery	30	(10)	40	(10)	50	(4)	27	(11)
Urology	62	(34)	63	(35)	61	(38)	62	(34)
Other	19	(16)	38	(16)	25	(371)	28	(423)
Total[a]	52	(1,686)	59	(1,572)	52	(2,028)	51	(2,207)

a. Total includes specialties not shown separately in this table.

Which specialties might need more senior officers?

One of the considerations in shaping the medical corps is the need to maintain enough experienced physicians who can provide leadership and supervise junior doctors. A trend toward a more junior medical corps would be a sign that accessions were not keeping up with attrition.

Table 7 shows the evidence regarding experience, from 1983 to 1994. It shows that anesthesiology, emergency medicine, and orthopedic surgery are made up of predominantly (70 percent or more) junior personnel. OB/GYN also has over 70 percent junior personnel, which is more than it did in the 1980s. The numbers indicate that these specialties might need to be given higher priority for GME. When we compare the rates in the 1990s with those in the 1980s, we can see that the medical corps force is slightly more senior than it was in the 1980s—a sign that the Navy is not facing the severe physician retention problems that it did in the 1980s. For example, the specialties of family practice and general internal medicine had over 70 percent junior personnel in 1987, but those fields now have a larger percentage of senior officers than in 1987.

Any one indicator, such as percentage of junior officers, is insufficient by itself. Some might claim that the worst crises are faced by specialties that have a large number of senior officers waiting to retire. For that reason, our next criterion focuses on recruitment, not seniority.

Which specialties will be most difficult to recruit?

Another criterion for giving priority to GME programs is to keep those programs for which shortages in the market will occur. By this reasoning, we would retain or even increase the size of programs for specialties in shortage, and decrease the size of those programs for which surpluses are predicted. The Navy might be able to recruit physicians from specialties that have a surplus via direct accessions. For example, the American Medical Association [26] and Bureau of Health Professionals [27] make projections that might prove to be useful.

Ideally, we would want to use data such as that shown in table 8 to make decisions about the priority of specialty programs. Table 8 shows that emergency medicine, preventive medicine, and general psychiatry are likely to incur shortages, whereas neurosurgery and endocrinology are likely to be in surplus. Unfortunately, we believe that the supply/demand picture changes too rapidly to be sure that table 8 is

still relevant to the current outlook. For example, there is anecdotal evidence that anesthesiologists are in oversupply—quite different from the findings shown in table 8.

Table 8. Ratio of projected supply to needs, 1990 [29]

Specialty	Ratio (percentage)	Needs	Surplus (shortage)
Shortages			
Child psychiatry	45	9,000	(4,900)
Physical medicine	60	4,050	(1,650)
Emergency medicine	70	13,500	(4,250)
Preventive medicine	75	7,300	(1,750)
General psychiatry	80	38,500	(8,000)
Near balance			
Therapeutic radiology	85	2,550	(400)
Anesthesiology	90	22,150	(2,000)
Hematology/oncology	90	9,000	(700)
Dermatology	105	6,950	400
Gastroenterology	105	6,500	400
Osteopathic general practice	105	22,750	1,150
Family practice	105	61,300	3,100
Internal medicine	105	70,250	3,550
Otolaryngology	105	8,000	500
Pathology	105	15,900	950
Neurology	105	8,350	300
Pediatrics and subspecialties	115	36,400	4,950
Surpluses			
Urology	120	7,700	1,650
Diagnostic radiology	135	19,200	6,450
Orthopedic surgery	135	15,100	5,000
Ophthalmology	140	11,600	4,700
Thoracic surgery	140	2,050	850
Infectious disease	145	2,250	1,000
OB/GYN	145	24,000	10,450
Plastic surgery	145	2,700	1,200
Allergy/immunology	150	2,050	1,000
General surgery	150	23,500	11,800
Nephrology	175	2,750	2,100
Rheumatology	175	1,700	1,300
Cardiology	190	7,750	7,150
Endocrinology	190	2,050	1,800
Neurosurgery	190	2,650	2,450

The Council on Graduate Medical Education's (COGME's) more recent report [28, p. 1.] avoids making specific specialty-by-specialty projections, except to say that it expects an oversupply of specialists:

> The growth in managed care will magnify the physician workforce concerns expressed by COGME in prior reports, that there is a large and growing oversupply of physicians overall and especially of specialists and subspecialists, and that there is a modest need for more generalist physicians.

If the COGME is correct, it might be that specialists will become easier to recruit for the Navy in coming years, until equilibrium is reached in the civilian sector.

Summary of results

Table 9 summarizes the results of phase 1, our descriptive analysis of attrition and experience patterns in the medical corps. One goal of GME is to increase retention beyond what you would expect if you had HPSP accessions train in civilian residencies. In column 2, we see that having been trained in GME improves retention the most for anesthesiology and family practice, making them the highest priority GME programs for the "improvement of retention" criterion.

Since GME in general improves retention, another criterion would be to retain specialties that have the highest attrition rates. Column 3 of the table shows the results of our analysis of *overall* attrition rates. By that criterion, OB/GYN, orthopedics, ENT, plastic surgery, neurosurgery, radiology, anesthesiology, and urology programs should achieve the highest priority for retention. Column 4 shows the results if the attrition rate is restricted to *end of initial obligation* attrition. The results are similar to the findings for overall attrition: orthopedics, anesthesiology, and ENT should be the highest priority GME programs. By that criterion, general surgery is also very high priority.

Another goal for community managers is to maintain each specialty with more than 70 percent physicians with less than 5 years of experience past residency. Because GME has a positive effect on retention, we should retain or enlarge programs in those specialties with a high percentage of junior personnel (with experience less than or equal to 5 years). By that criterion, column 5 shows that OB/GYN, orthopedics, emergency medicine, anesthesiology, and ENT should be retained or enlarged.

Table 9. Summary of findings from phase 1, by rank[a]

Specialty	Difference between deferred and in-house GME attrition at end of initial obligation	Overall attrition rate	End of initial obligation attrition rate	Percentage of specialty with <= 5 years experience	Degree of shortage	Average rank
Anesthesiology	1	1	1	1	1	1.0
Orthopedics	2	1	1	1	2	1.4
Emergency medicine[b]	2	1	2	1	1	1.4
OB/GYN	2	1	2	1	2	1.6
ENT	2	1	1	2	2	1.6
Family practice	1	2	2	2	2	1.8
General surgery	2	2	1	2	2	1.8
Internal medicine	2	1	2	2	2	1.8
Psychiatry	2	2	2	2	1	1.8
Radiology	2	1	2	2	2	1.8
Ophthalmology	2	1	2	2	2	1.8
Pediatrics	2	23	2	2	2	2.0

a. A ranking of 1 means the highest priority for retaining or enlarging the program, and a ranking of 2 means lower priority.
b. We placed emergency medicine below orthopedics because the MOSR requires more orthopedic surgeons.

The final criterion was that we should enlarge or retain programs in specialties in which there is shortage. By that criterion, emergency medicine, psychiatry, and anesthesiology should be given priority. The findings for that criterion are shown in column 6 of table 9.

There are many ways of putting these findings together, and any way of putting them together will involve some degree of arbitrariness. One problem has to do with scaling: should a 1-percent difference in overall attrition be considered as important as a 1-percent difference in end-of-initial-obligation attrition? This is complicated by the fact that there are unequal numbers of specialties for which rankings are statistically meaningful. For example, anesthesiology and family practice will be given much credit for being in a category for which only two specialties showed statistically significant differences between deferred and in-house GME. Furthermore, one could argue that counting overall attrition and end-of-initial-obligation attrition "double-count" the single concept of attrition.

We believe that the two types of attrition are distinct, but some may disagree. Given all these considerations, it is clear that value judgments are inevitable in making use of these data.

We recommend one approach to the problem because of its simplicity. The approach is to award points to specialties based on their average rank across columns. For example, we award anesthesiology and family practice each a rank of 1 for column 2. All other specialties get a ranking of 2 because they were not in the "highest priority" specialties by that criterion. By limiting the scale to a "1" for highest priority and "2" for all others, no specialty gets overweighted because it is extreme on any one criterion.

The results of this system can be seen in the final column of table 9, "average rank." Giving equal weight to the five indicators we chose, anesthesiology, orthopedics, and emergency medicine should be high-priority programs in Navy GME. By way of contrast, radiology, ophthalmology, and pediatrics should have lower priority.

Phase 2: Medical Corps Community Model

Overview

Phase 1 of our research has limits as a guide to policy because attrition rates should be evaluated in relation to rates in other parts of the system. For example, high attrition is a problem if there are few accessions, but if there are many new accessions, high attrition may be less of a problem. What matters is the relative size of the two rates. The problem becomes even more complicated if we consider such issues as changes in obligation rules and accession policies.

Our phase 2 product, the Medical Corps Community Model, is a tool that allows decision-makers to evaluate the joint effects of accession rates, attrition rates, and policy changes. It allows the user to project future sizes of the physician inventory by modifying default values for such variables as:

- Accession rates
- Attrition rates
- Obligation rules
- Residency lengths.

Our default values are based on historic attrition and accession rates. The decision-maker can modify our default assumptions by:

- Eliminating an accession source (e.g., USUHS)
- Reducing or enlarging an accession source (e.g., FAP, direct accessions)
- Changing attrition rates to equal those observed in the late 1980s, when there was a retention problem
- Adding a year to physicians' obligations

- Modifying the allowable percentage of medical corps in residency
- Changing the size of MOSR requirements and determining the size of projected shortfalls or surpluses.

The following paragraphs describe the purpose of a model, specify the algebraic form of the Medical Corps Community Model, present the model's default starting values and default transition values, and describe three of the many types of reports it can generate.

Purpose and form of a model

A model can be useful when decision-makers need to simultaneously take into account multiple events and draw out the implications of continuations of patterns. A model is mathematical and, therefore, an approximate representation of reality. A model is an abstraction or simplification: it must capture the important aspects of the community it deals with, yet be free of burdensome detail. As Wagner [29, p. 10] puts it:

> Constructing a model helps you put the complexities and possible uncertainties attending a decision-making problem into a logical framework amenable to comprehensive analysis. Such a model clarifies the decision alternatives and their anticipated effects, indicates the data that are relevant for analyzing the alternatives, and leads to informative conclusions. In short, the model is a vehicle for arriving at a well-structured view of reality.

Wagner goes on to say that "striking a proper balance between reality and manageability is no mean trick in most applications, and for this reason model-building can be arduous" [29, p. 11].

A good model accounts for system interactions, such as the tradeoffs between accession rates and attrition rates. It can be used as a tool to show how sensitive solutions are to changes in the model's parameters. Lastly, a good model simplifies only where simplification has inconsequential effects on the important results.

Our model divides inventory into length-of-service distributions and projects them into the future by means of continuation rates [23]. It is an expected value model and shows what occurs in a steady state if

those average rates continue into the future. It also provides a tool for showing the consequences if those rates change. Our computer adaptation of the model is not a Monte Carlo model that includes statistical distributions for specifying key variables, because we wanted to keep the run time reasonable. Therefore, we assume that expected values adequately capture important relationships.

Algebraically, we express the continuing inventory of fully trained physicians for each specialty, $CINV_s$, from year t to year $t+1$ as follows:

$$\sum_{k=1}^{k=2} CINV_{t+1,s} = \sum_{k=1}^{k=2} [INV_{t,s} * CR_s] \ , \qquad (1)$$

where $CINV$ is an array of the number of personnel with a given length of service at a particular point in time, and CR is a vector of length-of-service continuation rates, each specific to a particular specialty, s. The k index in the summation refers to the fact that we have two continuation rates for each specialty: (1) at end of initial obligation for direct accessions, and (2) at end of initial obligation for those who came in any way other than as direct accessions.

The total inventory of fully trained physicians for each specialty, $TINV_{t+1,s}$, is the sum of the continuing inventory and new inventory, including direct accessions in that specialty $[ACC_{DA}]_s$, those who are finishing a civilian residency as NADDS $[NINV_{NADDS}]_s$, those finishing in-house GME in a given year $[NINV_{GME}]_s$, and FAP $[ACC_{FAP}]_s$:

$$TINV_{t+1,s} = \left[\sum_{k=1}^{k=2} CINV_{t+1,s}\right] + [ACCDA_f]_s \qquad (2)$$

$$+ [NINV_{NADDS}]_s + [NINV_{GME}]_s + [NINV_{FAP}]_s \ .$$

The entry points of the model are one of the medical corps community's accession sources shown in figure 2, from HPSP, USUHS, or direct accessions:

- ACCHPSP

- ACCUSUHS
- ACCDA, which consists of two components—those who go into residency, $ACCDA_f$ (where f is for fully trained) and those who go into training, $ACCDA_c$ (where c is for cross-training).

The exit points for the model—separations—are either from attrition or from retirements. These values determine the continuation rate used in equation 1:

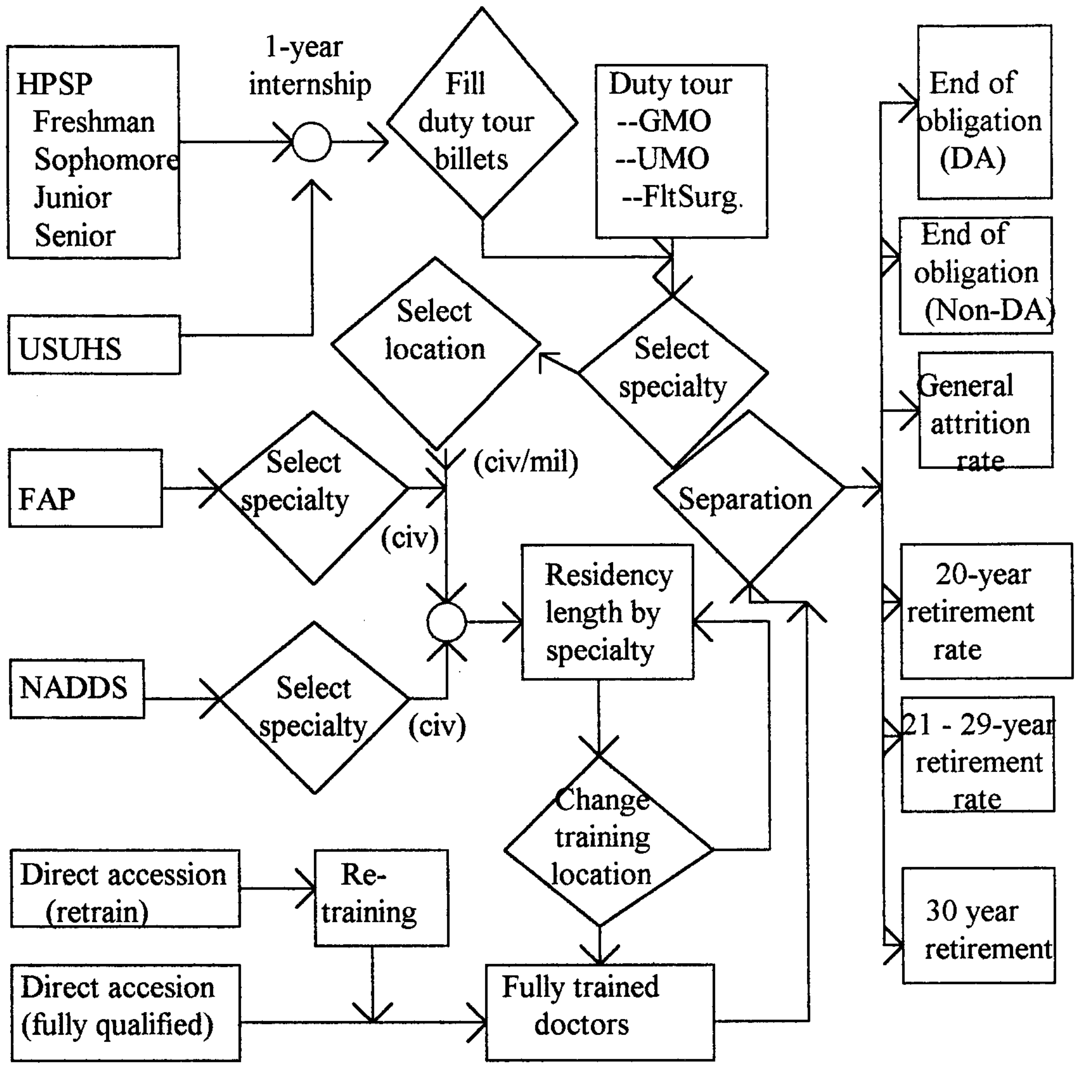
$$CR_s = 1 - [ATTDA_s + ATTND_s + ATTG_s + RET_{20} + RET_{21-29} + RET_{30}] \quad (3)$$

where *ATT* stands for attrition rate and *RET* is the retirement rate. Note that we have assumed, as others have [10], that retirements are influenced only by year of service, and not by specialty. Because few medical officers make it to 20 years, a breakdown by specialty and year of service yields too few cases to check on the validity of this assumption.

Given these comments about the form of the model, what can the model do? It allows the user to do the following:

- Evaluate the effect of changing starting values and accession rates.
- Change the names and number of medical corps specialties.
- Change the number of years that the model runs.
- Evaluate the effects of changing the number and length of duty tours.
- Observe the effects of changing separation rates by specialty or, for retirements, by year of service.
- Change the length of obligations for each accession source.
- Change individual data records.
- Change residency lengths.
- See changes year by year, if desired.
- Keep a record of the changes made for each new scenario.

Figure 2. Flowchart of the Medical Corps community model



Of course, any model has its limitations. So, what is the model *not* able to do? The model cannot work backwards, changing accession policies to obtain a particular force size. This is because it is a matter of policy to decide *which* accession sources should be changed—or by how much—to accommodate new endstrength goals. However, if the user can specify an accession policy, the model can be useful for showing how that policy can obtain a particular force size.

Other functions that the model cannot yet perform include:

- Account for second or later term residencies and fellowships. (We do distinguish between attrition from Navy and progression to a specialty, however.)
- Compute the effects of attrition from medical school (we assume that everyone who starts medical school also finishes).
- Account for shifts in specialty during a physician's career.
- Account for the number and specialties of physicians who leave the Navy while still under obligation.

Keep in mind that the results of the model are only as robust as the BUMIS file. Our model relies heavily on projected rotation dates and obligated service dates, and many of those dates appeared not to be updated consistently. For example, a number of physicians had past-due projected rotation dates and obligated service dates. We chose to move those with out-of-date projected rotation dates first, with unknown effects on the validity of our results for the early years of our model runs.[12]

Model default inputs

All default starting values for the community at the beginning of model runs were from the end of fiscal 1994, using the BUMIS data

12. The advantage of the Medical Corps Community Model is not in near-term predictions, which are followed in great detail at codes within the Navy and Navy medicine, but in showing the middle- and long-term consequences of continuation of accession rates, attrition rates, and obligation policies. The model does not make value judgments, such as how GME affects local health care organizational effectiveness.

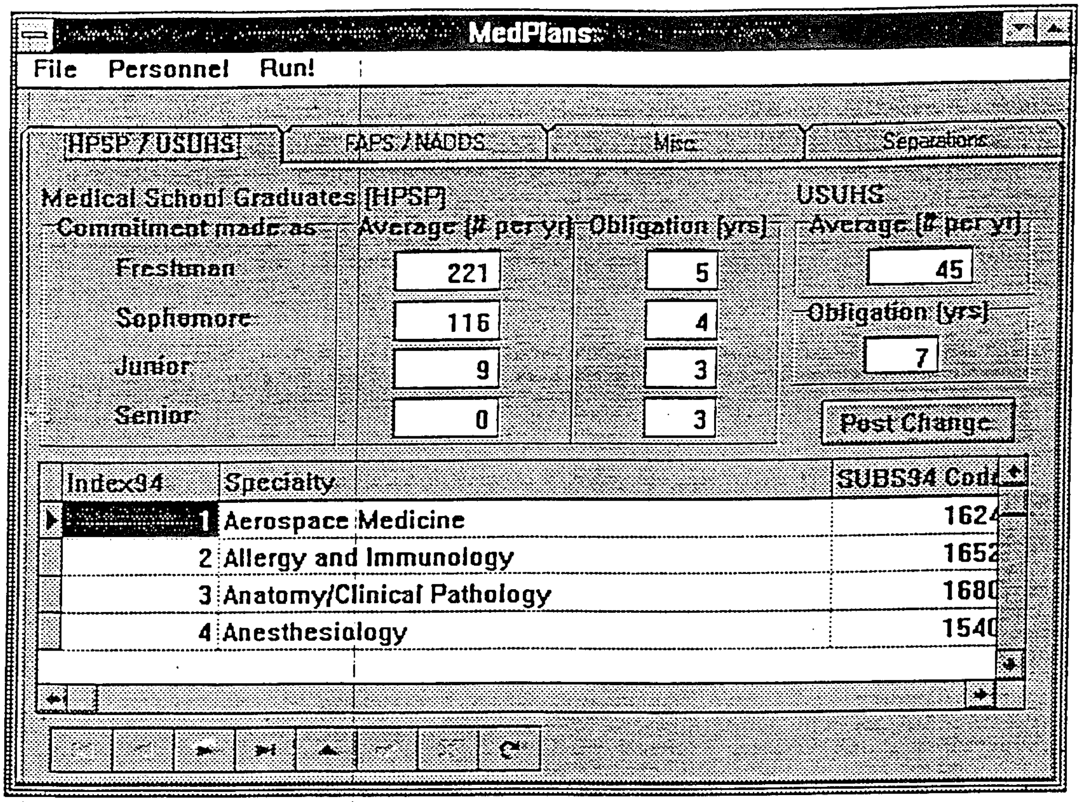
file to ascertain each medical corps doctor's active commission base date (to determine when the officer would be eligible for retirement, and to calculate experience profiles at various points in time), projected rotation date (to determine when the physician began a particular tour), and obligated service date (to determine when particular physicians would be eligible to leave the Navy, if they are not already unobligated).

Table 10 has the default starting values that we used. We compared these numbers with the October 1994 Monthly Specialty Report [19], finding that we had just 7 fewer medical corps than did the specialty report, which reported 4,305. Because the October 1994 report is 31 days after the end of the fiscal year, the small difference between our default values and MED-512's report is confirmation that our model's defaults are reasonable. Note that all starting values can be changed in a set of easy-to-use input screens. Figure 3 is an example of such a screen.

Table 10. Default starting (1994) values for the Medical Corps Community Model

Data set	Direct accessions	Nondirect accessions	Total
Fully trained duty tours	0	217	217
Fully trained direct accessions	588	0	588
Fully trained nondirect accessions	0	2,160	2,160
Interns	0	272	272
Residents	52	820	872
NADDS and FTOS	0	176	176
FAP	13	0	13
Total	653	3,645	4,298

Figure 3. Sample input screen to the Medical Corps Community Model



Default transition values

Accessions

For accessions, we provided a default that the Navy would have 45 USUHS entrants each year, who leave medical school with 7-year obligations. We use the number 45 because that has been the Navy's share of USUHS entrants each year. We assume no attrition from medical school. The model's default for direct accessions is 65 per year, 20 going into a military residency and 45 immediately going into direct care. Our figure of 65 direct accessions is the average yearly number from the last 4 years for which we had data (1990–1993). Direct accessions begin with an obligation of 3 years in our default. For simplicity, we took FAP participants as a kind of direct accession, ignoring the possibility that they could also have received HPSP earlier. Because the FAP is still a relatively minor source of accessions for the Navy, our default assumed only 10 FAP participants entering per year.

The major source of accessions is HPSP. For the default values in our model, we took the number of HPSP accessions for 1994. In this way, we assumed that an average recruitment year for HPSP accessions would net 221 medical school freshmen, 116 sophomores, and 9 juniors, for a total of 346 accessions. The initial obligation status for these HPSP accessions would be 4 and 3 years, respectively.

Residencies

For default lengths of residencies, we used information provided by the former Naval Health Sciences Education and Training Command (HSETC), and supplemented that information with the *Graduate Medical Education Directory*, 1994-1995 [30]. Table 11 shows the residency lengths that we received from HSETC.

Our defaults used the 1990–1994 average rates of specialty selection for HPSP and USUHS graduates. We also assigned as default values the 1990–1994 average rates for NADDS, FAP participants, and their specialty selections (see tables 12 and 13). The model's yearly default for NADDS is 50.

Duty tours

Our initial default value for the number of duty tour[13] billets was 217. For our default values, we assumed that each year all available USUHS graduates (45) would go into a duty tour, with an average of 156 HPSP graduates going into duty tours (as flight surgeon, general medical officer, or undersea medical officer), and 16 NADDS to fill out the rest of the duty tour billets. Table 14 shows the number of HPSP graduates going into duty tours for 1991 through 1994, plus the average rate at which they filled flight surgeon, GMO, and UMO billets. Our value of 217 was based on our reading of previous work [18], but the model allows the user to modify those values if he or she feels it would be useful.

13. Duty tours are assignments to operational fleet or Marine units, usually taken by a physician who has finished internship but not residency. The billets are GMO, flight surgeon, or UMO. Duty tours reduce the physician's obligation by 2 years.

Table 11. Default values for full-time in-service residency and fellowship programs

Program	Type of program	Length in years
Adolescent medicine	Fellowship	3
Aerospace medicine[a]	Residency	3
Anesthesiology	Residency	3
Cardiology	Fellowship	3
Cytopathology	Fellowship	1
Dermatology	Residency	3
Emergency medicine	Residency	3
Endocrinology	Fellowship	2
Family practice	Residency	2
Gastroenterology	Fellowship	2
Hematology/oncology	Fellowship	3
Hematopathology	Fellowship	1
Infectious disease	Fellowship	2
Internal medicine	Residency	2
Nephrology	Fellowship	2
Neurology	Residency	3
Neurosurgery	Residency	6
Nuclear medicine	Residency	2
Obstetrics/gynecology	Residency	3
Ophthalmology	Residency	3
Orthopedics	Residency	4
Otolaryngology	Residency	5
Pathology	Residency	4
Pediatrics	Residency	2
Psychiatry	Residency	3
Psychiatry	Residency	3
Pulmonary/critical care	Fellowship	3
Radiology	Residency	4
Radiology—imaging	Fellowship	1
Surgery	Residency	4
Urology[b]	Residency	4
Urology	Residency	5

a. Aerospace medicine is a 1-year FTOS program immediately followed by a 2-year FTIS program.

b. The Navy has two urology programs of different lengths. It expects to standardize the lengths in the future.

Table 12. Default values for FAP specialty choice percentages

Specialty name	Choice percentage
Anesthesiology	6.1
Emergency medicine	9.1
Family practice	9.1
General surgery	18.2
Internal medicine	30.3
Neurology	3.0
OB/GYN	9.1
Orthopedic surgery	6.1
ENT/head & neck	3.0
Pediatrics	3.0
Psychiatry	3.0

Table 13. Default values for NADDS specialty choice percentages

Specialty name	Choice percentage
Anatomy/clinical pathology	1.7
Anesthesiology	9.7
Dermatology	0.6
Diagnostic radiology	5.7
Emergency medicine	0.6
Family practice	10.2
General surgery	11.4
Internal medicine	2.8
Cardiology/internal med.	0.6
Neurosurgery	4.5
OB/GYN	22.1
Ophthalmology	0.0
Orthopedics	21.5
ENT/head & neck surgery	1.1
Med-Peds	0.6
Spine surgery	0.6
Radiation oncology	0.6
Cardio-thoracic surgery	2.3
Reconstructive surgery	0.6
Urology	2.8

Table 14. Default values for model and actual distribution of HPSP seniors filling duty tours, 1991–1994

Duty tour specialty	1991	1992	1993	1994	1991–1994 average/default
Flight surgeon	42	16	13	36	26.75
GMO	120	77	133	145	118.75
UMO	20	8	6	9	10.75
Total	182	101	152	190	156.25

Separations

Our model has two kinds of default separation values: attrition and retirements. Table 15 shows the default attrition rates. We used the average initial unobligated attrition rate for direct accessions (.43) and for nondirect accessions (.53) whenever we had too few cases to compute a separate rate for that specialty. The default rates for general attrition shown are the continuation rates we computed. Our default values for retirement percentages depended only on the number of years the medical corps officer had been in the Navy, not on specialty. Those default values were .19 for retirement rates at 20 years, .25 for 21 to 29 years, and 1.00 (a certainty of retirement) at 30 years. These values for retirement rates were somewhat lower than in the late 1980s. At that time, the retirement rate was .33 at 20 years, .27 for 21 years, and .24 for more than 21 years [10].

Examples of analysis options and output

In this subsection, we provide examples of the kinds of analyses that the Medical Corps Community Model can generate. The model can be used to address a wide variety of force management questions. Here we show examples of three:

1. How will the medical corps of the future compare to today's levels if historical trends continue?

2. How will the medical corps of the future compare to today's levels if attrition increases?

3. How would increased FAP recruiting affect the medical corps' ability to meet the so-called 25-50-75 requirements?

Table 15. Default attrition rates for Medical Corps Community Model

Specialty	Initial obligated attrition		Later attrition for all medical corps 1990–1994
	Direct	Nondirect	
Aerospace medicine	0.04	0.04	0.14
Anatomy/clinical pathology	0.14	0.18	0.14
Anesthesiology	0.65	0.81	0.22
Colon and rectal surgery	0.43	0.53	0.15
Dermatology	0.22	0.28	0.17
Diagnostic radiology	0.38	0.48	0.23
Emergency medicine	0.43	0.53	0.21
Family practice	0.22	0.28	0.16
Flight surgery—(aviation medicine)	0.34	0.44	0.22
General surgery	0.24	0.3	0.16
General medical officer	0.54	0.67	0.64
Internal medicine	0.46	0.57	0.19
Neurology	0.26	0.33	0.17
Neurosurgery	0.46	0.57	0.24
Obstetrics/gynecology	0.44	0.55	0.27
Occupational health	0.04	0.04	0.12
Ophthalmology	0.18	0.23	0.2
Orthopedic surgery	0.7	0.88	0.25
ENT/head & neck surgery	0.43	0.53	0.25
Pediatrics	0.31	0.39	0.16
Physical medicine and rehabilitation	0.43	0.53	0.15
Plastic surgery	0.43	0.53	0.24
Preventive medicine	0.04	0.04	0.13
Psychiatry	0.12	0.15	0.13
Thoracic surgery	0.43	0.53	0.14
Undersea medicine	0.26	0.33	0.3
Urology	0.26	0.33	0.22
Other	0.43	0.53	0.25

To answer each question, the user must specify the scenario by setting accession rates, specialty choice rates, length of obligations, and attrition rates. The default values for these rates are based on historical levels.

Model outputs

For all questions and scenarios that the user inputs, the model generates three different outputs. These output files compare numbers of fully trained physicians against two standards of physician requirements: 1994 MOSR requirements and 1994 authorized billets. The outputs provide yearly inventories of the:

- Numbers of each of 103 specialties—fully trained or in training—as compared to the MOSR requirements and 1994 authorizations
- Relative size of physician training inventory in Navy in-house training vs. the amount in civilian institutions
- Initial source of physician accessions.

Sample analyses

Scenario 1

Scenario 1 asks: How will numbers of medical corps in 2010 compare with MOSR requirements and 1994 authorized billets, given historical (default) rates of accessions, specialty choice, and attrition?

This question assumes the default scenario, so it is fairly easy to answer. Table 16 shows the number of fully trained physicians providing care and serving duty tours[14] in 2010. These defaults seem reasonable given earlier studies. The next two columns provide standards of comparison, MOSR and 1994 authorizations. The final columns provide the comparison results—from the largest predicted MOSR shortfall (emergency medicine) to the largest surplus (GMO).

Table 16 provides more complete considerations for setting GME priorities than did phase 1 of this study. For example, flight surgery seems a more likely area of shortfall than it did in phase 1, when attrition rates were looked at without benefit of simultaneous consideration of accession rates. Conversely, OB/GYN appears to be less of a concern than it appeared in phase 1, in part, because there is a relatively large NADD inventory in OB/GYN. Another advantage of the model's results is that they provide *not just a ranking of specialties, but an estimate of the size of any*

14. Also, note that appendix D provides the values for all 103 specialties that are abbreviated in table 16.

Table 16. Specialties sorted by predicted MOSR shortfall, default scenario, end FY 2010[a]

Specialty	Fully trained physicians, 2010	Duty tours, 2010	MOSR requirements	1994 authorizations	Delta from MOSR	Delta from authorizations
Emergency medicine	43	0	113	71	-70	-28
General surgery	125	0	191	150	-66	-25
Anesthesiology	139	0	199	142	-60	-3
Flight surgery—(aviation medicine)	175	27	254	295	-52	-93
Family practice	219	0	262	257	-43	-38
Preventive medicine	6	0	26	28	-20	-22
Psychiatry	58	0	76	96	-18	-38
Aerospace medicine	13	0	29	39	-16	-26
Undersea medicine	58	11	80	94	-11	-25
Colon and rectal surgery	5	0	8	9	-3	-4
Pediatrics	58	0	60	103	-2	-45
Dermatology	20	0	21	37	-1	-17
Other	2	0	0	0	2	2
Urology	36	0	33	32	3	4
Neurosurgery	24	0	21	18	3	6
Internal medicine	113	0	109	119	4	-6
Thoracic surgery	13	0	8	16	5	-3
Ophthalmology	25	0	19	38	6	-13
Neurology	21	0	15	24	6	-3
Occupational health	20	0	10	30	10	-10
Anatomy/clinical pathology	52	0	30	68	22	-16
Internal medicine, cardiology	22	0	0	34	22	-12
Orthopedic surgery	172	0	143	105	29	67
ENT/head and neck surgery	65	0	29	41	36	24
Diagnostic radiology	86	0	47	81	39	5
Obstetrics/gynecology	168	0	79	111	89	57
General medical officer	375	119	297	448	197	46

a. Numbers for flight surgery and general medical officers (GMOs) are highly affected by processes not modeled. The number of flight surgeons is influenced by transfers from other specialties, so their numbers will actually be larger than shown here. The GMO number shown here is inflated because it includes physicians who have finished an operational tour, have decided to finish their obligation, and possibly will seek residency training after leaving the Navy.

predicted shortfall. For example, there is a large gap between the shortfalls predicted for family practice (-43) as opposed to preventive medicine (-20). If the specialties had merely been ranked, we would conclude that family practice and preventive medicine are very similar—in fact, the size of their shortfalls are quite different, as table 16 shows.

The model allows decision-makers to see the results of changing the assumptions on predicted future inventory: a sensitivity analysis. To show the model's capability to perform sensitivity analyses, our second scenario changes the default attrition rates to match those seen in the late 1980s. Table 17 shows the values that the model computed. It answers the following question.

Scenario 2

Scenario 2 asks: If medical corps retention deteriorated to the level of the late 1980s, what would be the largest areas of shortfall (given historical accession and specialty choice rates)?

Table 17 shows the results of our model when using the (usually) higher attrition rates of the 1980s, as reported in an earlier CNA publication [10]. It shows that, although the predicted sizes of MOSR shortages increase, the relative ordering of the general classes of specialties has not changed much from the findings of scenario 1. In scenario 2, the five specialties with the largest MOSR shortfalls are the same as they were with the defaults from scenario 1; the four specialties with the largest surpluses also remain unchanged. Note, however, that family practice rises from the fifth worst problem filling MOSR requirements in scenario 1 to the worst problem in scenario 2.

A final example shows how the model can help decision-makers determine the management implications of particular manpower policies. For example, it will allow the user to compute the percentage of the medical corps that is in GME, NADDS, and FAP, and compare those percentages to the "25-50-75 rule."[15]

15. This rule states, roughly, that the overall medical corps can have no more than 25 percent of its personnel in residency training at any one time, and that between 50 and 75 percent of specialists should be from in-house GME (FTIS). At the time this memorandum was written, specifics about how these percentages should be computed were unclear. For example, should "fair share" and TPP&H be counted for these ratios?

Table 17. Specialties by predicted MOSR shortfall, scenario 2 (1980s retention rates)[a]

Specialty	Fully trained physicians, 2010	Duty tours, 2010	MOSR requirements	1994 authorizations	Delta from MOSR	Delta from authorizations
Family practice	175	0	262	257	-87	-82
Anesthesiology	113	0	199	142	-86	-29
General surgery	112	0	191	150	-79	-38
Emergency medicine	43	0	113	71	-70	-28
Flight surgery—(aviation medicine)	169	27	254	295	-58	-99
Psychiatry	44	0	76	96	-32	-52
Pediatrics	40	0	60	103	-20	-63
Preventive medicine	6	0	26	28	-20	-22
Undersea medicine	51	11	80	94	-18	-32
Aerospace medicine	13	0	29	39	-16	-26
Internal medicine	94	0	109	119	-15	-25
Orthopedic surgery	137	0	143	105	-6	32
Colon and rectal surgery	3	0	8	9	-5	-6
Plastic surgery	5	0	8	8	-3	-3
Dermatology	21	0	21	37	0	-16
Other	0	0	0	0	0	0
Neurosurgery	23	0	21	18	2	5
Ophthalmology	22	0	19	38	3	-16
Urology	36	0	33	32	3	4
Occupational health	15	0	10	30	5	-15
Neurology	20	0	15	24	5	-4
Thoracic surgery	14	0	8	16	6	-2
Neonatology	7	0	0	8	7	-1
ENT/head and neck surgery	46	0	29	41	17	5
Anatomy/clinical pathology	50	0	30	68	20	-18
Diagnostic radiology	75	0	47	81	28	-6
Obstetrics/gynecology	152	0	79	111	73	41
General medical officer	373	119	297	448	195	44

a. Numbers for flight surgery and general medical officers (GMOs) are highly affected by processes not modeled. The number of flight surgeons is influenced by transfers from other specialties, so their numbers will actually be larger than shown here. The GMO number shown here is inflated because it includes physicians who have finished an operational tour, have decided to finish their obligation, and will possibly seek residency training after leaving the Navy.

The model will allow the user to see how well the medical corps community follows the 25-50-75 rule if values for accessions, attrition, and specialty choice remain constant over a period of years. By computing the relevant ratios for the 25-50-75 rule, the model could answer questions such as that posed in scenario 3.

Scenario 3

If the Navy succeeded in recruiting 60 FAP participants a year (roughly the number that the Air Force has recruited in recent years [24]), and changed the obligation lengths for HPSP and USUHS, what would be the ratio of in-house training to the entire inventory of physicians being trained?

Table 18 shows the results that would follow if (1) attrition rates increased to the levels of the late 1980s, (2) the Navy succeeded in recruiting 60 FAP participants per year,[16] and (3) there was a change in obligation lengths. This example shows the true usefulness of a model, which allows one to assess the joint effect of changes in the outside world (reflected in attrition rates) and changes in policy (such as goals for FAP recruiting). It shows that, with the additional 50 FAP participants per year, the Navy stays well below the ceiling of no more than 75 percent of training being in-house residencies. The percentage of in-house training remains at about 60 percent during the period 2006 to 2010. The number in FTIS training (in-house, column 2) has almost reached a steady state by 2010; if the model were run further, we believe that a steady state would be reached by about 2015.

16. In this example, we are adding 50 more FAP participants to our historical value of 10 per year; however, the model could also be used to asssess the results of substituting FAP participants for other accession sources.

Table 18. Percentage of training occurring in-house, scenario 3 (increased attrition, increased FAP participants, changes in obligation lengths)[a]

End of FY	In-house training	Civilian training	In-house ratio
2000	986	745	0.57
2001	946	676	0.58
2002	866	639	0.58
2003	904	638	0.59
2004	892	636	0.58
2005	925	634	0.59
2006	916	638	0.59
2007	945	632	0.60
2008	924	636	0.59
2009	964	634	0.60
2010	924	645	0.59
Average	927	650	0.59

a. This report can be found in the model's output file, 'loghosp.dbf'.

Conclusions

In phase 1 of this research, we presented a variety of analyses to help determine the relative priority among GME programs. We believe that attrition patterns should be considered a significant factor in shaping the specialty size of GME programs.

Based on our attrition analyses, we presented the following criteria for setting GME priorities:

- In-house GME program has a relatively high positive impact on retention.
- The specialty has a high attrition rate.
- The specialty has a relative shortage of senior officers.
- The specialty is difficult to recruit.

Specialties that meet these criteria should be given higher priority for remaining at their current size. Giving equal weight to answers to these four criteria, we found that anesthesiology, orthopedics, and emergency medicine should be high-priority programs in Navy GME. By way of contrast, radiology, ophthalmology, and pediatrics should have comparatively low priority. Of course, these tentative conclusions should be supplemented by clinical considerations.

In phase 2, we developed a Medical Corps Community Model that shows the consequences of policy changes and new trends in accession or retention rates. As such, the model presents an important tool to the decision-maker for answering the following kinds of questions:

1. *Trend questions,* such as, "How do predicted numbers of medical corps personnel compare to MOSR requirements and to 1994 authorized billets given different assumptions about rates of accessions, specialty choice, and attrition?"

2. *Policy questions,* such as, "If the Navy changes its recruiting sources and obligation rules, to what extent could the additional recruits and policy change compensate for an attrition rate like that of the late 1980s?"

In conclusion, the two phases of this research help evaluate options for sizing GME programs. Although we believe this work is useful, we did not explore all considerations relevant to setting GME policy. Some nonquantifiable considerations are important too, such as the relative substitutability of specialists for one another. When quantifiable considerations are combined with the clinical judgment and experience of BUMED personnel, we believe that better decisions can be made concerning the size of GME programs.

Appendix A: Fully trained attrition rates, 1990–1993

Table 19. Fully trained attrition rates, 1990-1993, obligated and unobligated medical corps

Specialty	1990		1991		1992		1993		1990-1993	
	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis
Aerospace medicine	0.03	35	0.03	40	0.13	40	0.03	37	0.05	152
Allergy and immunology	0.00	12	0.07	14	0.00	15	0.13	15	0.05	56
Anatomy/clinical pathology	0.08	80	0.15	82	0.16	75	0.07	71	0.11	308
Anesthesiology	0.21	141	0.20	160	0.16	174	0.20	182	0.19	657
Anesthesiology critical care	NA	0	NA	0	0.00	1	0.00	1	0.00	2
Cardiovascular electrophys	NA	0	NA	0	NA	0	0.00	1	0.00	1
Child neurology	0.25	4	0.00	3	0.67	3	0.00	2	0.25	12
Child psychiatry	0.00	6	0.00	10	0.00	13	0.21	14	0.07	43
Colon and rectal surgery	0.00	4	0.13	8	0.17	6	0.00	6	0.08	24
Cytopathology	NA	0	NA	0	NA	0	0.00	3	0.00	3
Dermatopathology	0.00	2	0.00	4	0.25	4	0.00	3	0.08	13
Dermatology	0.23	35	0.12	33	0.13	45	0.10	50	0.14	163
Developmental pediatrics	NA	0	0.20	5	0.00	4	0.25	4	0.15	13
Diagnostic radiology	0.18	92	0.22	98	0.19	94	0.20	97	0.20	381
Emergency medicine	0.18	44	0.24	51	0.13	55	0.18	67	0.18	217
Family practice	0.10	239	0.15	266	0.15	251	0.12	257	0.13	1,013
Family practice adolescent medicine	NA	0	NA	0	0.00	1	0.00	2	0.00	3
Family practice faculty development	NA	0	NA	0	NA	0	0.00	2	0.00	2
Family practice obstetrics	NA	0	NA	0	NA	0	0.00	1	0.00	1
Flight surgery—(aviation medicine)	0.10	246	0.13	269	0.14	290	0.16	303	0.13	1,108
Forensic pathology	0.00	3	0.00	4	0.25	4	0.14	7	0.11	18
General surgery	0.10	157	0.15	164	0.12	169	0.15	163	0.13	653
Gerontology	0.00	1	0.00	1	0.00	6	0.20	5	0.08	13
General medical officer	0.08	501	0.16	582	0.16	508	0.15	559	0.14	2,150
Glaucoma	0.50	2	0.00	1	0.00	2	0.50	2	0.29	7
Gynecologic oncology	0.33	3	0.00	3	0.00	7	0.11	9	0.09	22
Gynecologic pathology	0.00	1	0.00	1	0.00	1	0.00	1	0.00	4
Hand surgery	0.11	9	0.33	9	0.00	7	0.33	9	0.21	34

Table 19. Fully trained attrition rates, 1990-1993, obligated and unobligated medical corps (continued)

	1990		1991		1992		1993		1990-1993	
Specialty	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis
Health management	NA	0	NA	0	NA	0	NA	0	NA	0
Hematopathology	0.00	4	0.20	5	0.00	5	0.20	5	0.11	19
Hyperbaric medicine	0.00	3	0.00	3	0.00	2	0.67	3	0.18	11
Imaging radiology	NA	0	NA	0	NA	0	0.00	1	0.00	1
Immunopathology	NA	0	NA	0	NA	0	NA	0	NA	0
Interventional cardiology	NA	0	NA	0	NA	0	0.50	2	0.50	2
Interventional radiology	NA	0	NA	0	NA	0	0.00	1	0.00	1
Internal medicine	0.17	127	0.16	122	0.15	115	0.16	110	0.16	474
Internal medicine, cardiology	0.21	24	0.16	32	0.22	32	0.33	30	0.23	118
Internal medicine, critical care	0.00	2	0.33	3	0.00	6	0.00	10	0.05	21
Endocrinology, diabetes, metabolism	0.10	10	0.00	10	0.13	8	0.22	9	0.11	37
Internal medicine, gastroenterology	0.20	20	0.20	25	0.18	28	0.25	28	0.21	101
Inernal medicine, hematology, oncology	0.24	17	0.13	16	0.00	17	0.25	20	0.16	70
Internal medicine, infectious disease	0.00	24	0.11	28	0.11	27	0.11	27	0.08	106
Internal medicine, nephrology	0.09	11	0.08	12	0.13	8	0.25	12	0.14	43
Internal medicine, pulmonary disease	0.08	24	0.26	27	0.09	22	0.13	24	0.14	97
Maternal/fetal medicine	0.25	4	0.17	6	0.00	8	0.25	8	0.15	26
Neonatology	0.00	8	0.25	8	0.14	7	0.10	10	0.12	33
Neurology-critical care	NA	0	0.00	1	0.00	1	0.00	1	0.00	3
Neurology	0.20	25	0.25	20	0.05	21	0.08	24	0.14	90
Neuroophthalmology	NA	0	0.00	1	0.00	1	0.00	3	0.00	5
Neurophysiology	NA	0	NA	0	NA	0	NA	0	NA	0
Neuroradiology	0.00	2	0.20	5	0.17	6	0.50	6	0.26	19
Neurosurgery	0.15	20	0.18	17	0.31	16	0.24	17	0.21	70
Nuclear medicine	0.09	11	0.18	11	0.00	9	0.00	10	0.07	41
Obstetrics/gynecology	0.26	95	0.30	86	0.22	77	0.16	86	0.24	344
Occupational health	0.03	36	0.09	47	0.11	45	0.11	35	0.09	163

Table 19. Fully trained attrition rates, 1990-1993, obligated and unobligated medical corps (continued)

Specialty	1990		1991		1992		1993		1990-1993	
	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis
Oculoplastics	1.00	1	0.00	2	0.00	2	0.00	2	0.14	7
Ophthalmology	0.18	50	0.17	47	0.20	45	0.13	45	0.17	187
Ophthalmology C&E disease	0.00	2	0.00	2	0.33	3	0.00	2	0.11	9
Ophthalmologic pathology	NA	0	NA	0	0.00	1	0.00	2	0.00	3
Orthopedic surgery	0.16	86	0.20	100	0.21	102	0.30	105	0.22	393
Otolaryngology/H&N surgery	0.21	53	0.22	51	0.20	51	0.27	56	0.22	211
Otolaryngology, F&R surgery	NA	0	NA	0	NA	0	NA	0	NA	0
Oto	0.00	1	0.33	3	0.00	2	0.00	3	0.11	9
Pathology-dermatopathology	0.00	2	0.00	3	0.00	5	0.00	4	0.00	14
Pediatrics, adolescent medicine	0.11	9	0.00	8	0.38	8	0.00	5	0.13	30
Pediatric cardiology	0.00	7	0.11	9	0.38	8	0.00	5	0.14	29
Pediatric gastroenterology	0.00	1	0.00	1	0.00	1	0.00	2	0.00	5
Pediatric hematology/oncology	0.00	6	0.17	6	0.14	7	0.00	8	0.07	27
Pediatrics	0.12	137	0.11	135	0.11	127	0.18	130	0.13	529
Pediatrics, infectious disease	0.00	6	0.00	6	0.00	5	0.00	5	0.00	22
Pediatric nephrology	0.00	2	0.00	2	0.00	4	0.25	4	0.08	12
Pediatric oncology	NA	0	NA	0	NA	0	NA	0	NA	0
Pediatric orthopedics	0.17	6	0.17	6	0.40	5	0.67	3	0.30	20
Pediatric otolaryngology	NA	0	NA	0	NA	0	NA	0	NA	0
Pediatric pulmonary disease	NA	0	NA	0	NA	0	0.00	3	0.00	3
Pediatric radiology	NA	0	NA	0	NA	0	0.00	2	0.00	2
Pediatric surgery	0.00	4	0.00	2	0.50	2	1.00	1	0.22	9
Pediatric urology	0.00	2	0.25	4	0.00	3	0.33	3	0.17	12
Perinatal biology	NA	0	NA	0	0.00	1	0.00	1	0.00	2
Peripheral vascular surgery	0.25	4	0.20	5	0.00	7	0.14	7	0.13	23
Physical medicine and rehab	0.00	3	0.33	3	0.00	2	0.00	2	0.10	10
Plastic surgery	0.31	13	0.27	11	0.20	10	0.00	9	0.21	43
Preventive medicine	0.19	27	0.03	29	0.03	31	0.14	37	0.10	124

Table 19. Fully trained attrition rates, 1990-1993, obligated and unobligated medical corps (continued)

Specialty	1990		1991		1992		1993		1990-1993	
	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis	Attrition rate	Basis
Physical medicine and rehab	0.00	3	0.33	3	0.00	2	0.00	2	0.10	10
Plastic surgery	0.31	13	0.27	11	0.20	10	0.00	9	0.21	43
Preventive medicine	0.19	27	0.03	29	0.03	31	0.14	37	0.10	124
Psychiatry	0.05	100	0.07	109	0.10	118	0.15	120	0.10	447
Reproductive endocrinology	0.00	3	0.00	4	0.40	5	0.20	5	0.18	17
Retinal surgery	0.60	5	0.00	2	0.50	2	0.00	2	0.36	11
Rheumatology	0.00	7	0.00	8	0.13	8	0.13	8	0.06	31
Spine surgery	0.00	4	0.50	4	0.00	3	0.33	3	0.21	14
Sports medicine	NA	0	NA	0	NA	0	0.00	2	0.00	2
Strabismology	0.25	4	0.00	3	0.50	2	0.50	2	0.27	11
Surgical critical care	0.25	4	0.00	5	0.00	6	0.23	13	0.14	28
Surgical oncology	0.00	1	0.00	3	0.00	1	0.50	2	0.14	7
Therapeudic radiology	0.38	8	0.10	10	0.20	10	0.22	9	0.22	37
Thoracic surgery	0.25	4	0.20	5	0.00	8	0.09	11	0.11	28
Total joint surgery	NA	0	NA	0	NA	0	NA	0	NA	0
Tropical medicine	0.00	4	0.20	5	0.00	6	0.14	7	0.09	22
Undersea medicine	0.07	88	0.14	95	0.12	101	0.17	93	0.12	377
Urology	0.18	38	0.08	40	0.23	39	0.30	37	0.19	154
Urologic oncology	NA	0	0.00	2	0.00	3	0.00	4	0.00	9
Pediatric, critical care	NA	0	NA	0	NA	0	NA	0	NA	0
Pediatric, endo/met	0.00	3	0.25	4	0.00	3	0.25	4	0.14	14
Neuropathology	0.00	1	0.00	2	0.00	1	1.00	1	0.20	5
Other	0.00	2	NA	0	0.00	1	NA	0	0.00	3
Overall attrition rate	0.12		0.15		0.14		0.16			
Number on which rate is based (basis)		2,782		3,029		2,985		3,124		11,920

Appendix B: Attrition at end of initial obligation, 1990–1993

Table 20. Attrition at end of obligation, HPSP and direct accessions, 1990-1993

Specialty name	Basis	Number leaving within 1 year	1-year attrition rate
Aerospace medicine	16	2	0.13
Allergy and immunology	5	0	0.00
Anatomy/clinical pathology	55	17	0.31
Anesthesiology	109	70	0.64
Anesthesiology critical care	0	0	NA
Cardiovascular electrophys	0	0	NA
Child neurology	0	0	NA
Child psychiatry	2	1	0.50
Colon and rectal surgery	0	0	NA
Cytopathology	1	0	0.00
Dermatopathology	0	0	NA
Dermatology	41	10	0.24
Developmental pediatrics	4	0	0.00
Diagnostic radiology	58	28	0.48
Emergency medicine	53	18	0.34
Family practice	238	73	0.31
Family practice adolescent medicine	0	0	NA
Family practice faculty development	2	0	0.00
Family practice obstetrics	0	0	NA
Flight surgery--(aviation medicine)	292	98	0.34
Forensic pathology	3	0	0.00
General surgery	62	41	0.66
Gerontology	0	0	NA
General medical officer	334	116	0.35
Glaucoma	1	1	1.00

Table 20. Attrition at end of obligation, HPSP and direct accessions, 1990-1993 (continued)

Specialty name	Basis	Number leaving within 1 year	1-year attrition rate
Gynecologic oncology	8	0	0.00
Gynecologic pathology	0	0	NA
Hand surgery	1	0	0.00
Health management	0	0	NA
Hematopathology	0	0	NA
Hyperbaric medicine	1	0	0.00
Imaging radiology	0	0	NA
Immunopathology	1	1	1.00
Interventional cardiology	0	0	NA
Interventional radiology	0	0	NA
Internal medicine	87	44	0.51
Internal medicine, cardiology	28	24	0.86
Internal medicine, critical care	1	0	0.00
Internal med, endocrinology, diabetes, metabolism	9	3	0.33
Internal medicine, gastroenterology	27	19	0.70
Internal medicine, hematology, oncology	15	1	0.07
Internal medicine, infectious disease	35	7	0.20
Internal medicine, nephrology	16	8	0.50
Internal medicine, pulmonary disease	19	18	0.95
Maternal/fetal medicine	0	0	NA
Neonatology	8	0	0.00
Neurology-critical care	0	0	NA
Neurology	15	15	1.00
Neuroophthalmology	0	0	NA
Neurophysiology	0	0	NA
Neuroradiology	0	0	NA
Neurosurgery	8	7	0.88
Nuclear medicine	4	4	1.00
Obstetrics/gynecology	23	19	0.83
Occupational health	35	11	0.31
Oculoplastics	19	3	0.16
Ophthalmology	23	8	0.35
Ophthalmology C&E disease	15	4	0.27
Ophthalmologic pathology	0	0	NA

Table 20. Attrition at end of obligation, HPSP and direct accessions, 1990-1993 (continued)

Specialty name	Basis	Number leaving within 1 year	1-year attrition rate
Orthopedic surgery	46	38	0.83
Otolaryngology/ H&N surgery	46	27	0.59
Otolaryngology, F&R surgery	14	9	0.64
Oto	0	0	NA
Pathology-dermatopathology	2	0	0.00
Pediatrics, adolescent medicine	2	0	0.00
Pediatric cardiology	5	2	0.40
Pediatric gastroenterology	2	1	0.50
Pediatric hematology/oncology	2	0	0.00
Pediatrics	62	23	0.37
Pediatrics, infectious disease	47	19	0.40
Pediatric nephrology	0	0	NA
Pediatric oncology	2	0	0.00
Pediatric orthopedics	4	4	1.00
Pediatric otolaryngology	1	1	1.00
Pediatric pulmonary disease/pulmonology	0	0	NA
Pediatric radiology	0	0	NA
Pediatric surgery	4	0	0.00
Pediatric urology	4	2	0.50
Perinatal biology	0	0	NA
Peripheral vascular surgery	0	0	NA
Physical medicine and rehabilitation	7	0	0.00
Plastic surgery	9	3	0.33
Preventive medicine--general and public health	18	4	0.22
Psychiatry	48	15	0.31
Reproductive endocrinology	26	8	0.31
Retinal surgery	0	0	NA
Rheumatology	1	0	0.00
Spine surgery	0	0	NA
Sports medicine	3	0	0.00
Strabismology	4	0	0.00
Surgical critical care	9	2	0.22
Surgical oncology	7	2	0.29
Therapeudic radiology	0	0	NA

Table 20. Attrition at end of obligation, HPSP and direct accessions, 1990-1993 (continued)

Specialty name	Basis	Number leaving within 1 year	1-year attrition rate
Thoracic surgery	0	0	NA
Total joint surgery	3	0	0.00
Tropical medicine	2	0	0.00
Undersea medicine	33	22	0.67
Urology	29	17	0.59
Urologic oncology	12	6	0.50
Pediatric, critical care	0	0	NA
Pediatric, endo/met	2	1	0.50
Neuropathology	0	0	NA
Other	0	0	NA
Total	2,130	877	0.41

Appendix C: Full summary of findings from longitudinal database

Table 21. Full summary of findings from longitudinal database

Scale of priority to retain or enlarge	Difference between deferred and in-house GME attrition at end of initial obligation[a] (from table 4)	Overall attrition rate[b] (from table 5)	End of initial obligation attrition rate[b] (from table 6)	Percentage of specialty with <=5 years experience (from table 7)	Degree of shortage (from table 8)
1	Anesthesiology (.30)	OB/GYN (.24)	Orthopedics(.83)	OB/GYN (.73)	Emergency medicine (.70)
2	Family practice-T(.28)	Orthopedics-T (.22)	General surgery-T (.66)	Orthopedics (.73)	Preventive medicine (.75)
3		ENT -T(.22)	Anesthesiology-T (.64)	Emergency medicine (.72)	Psychiatry (.80)
4		Plastic surgery-T(.21)	ENT-T (.59)	Anesthesiology (.70)	Anesthesiology (.90)
5		Neurosurgery-T(.21)			Hematology/oncology(.90)
6		Radiology-T(.20)	Internal medicine (.51)	ENT (.65)	
7		Anesthesiology-T(.19)	Radiology(.48)	Dermatology(.64)	Dermatology (1.05)
8		Urology-T (.19)	Pediatrics(.37)	Urology (.62)	Family practice (1.05)
9		Emergency medicine-T(.18)	Emergency medicine(.34)	Family practice(.60)	Internal medicine(1.05)
10		Ophthalmology-T(.17)	Family practice(.31)	Radiology(.58)	ENT (1.05)
11		Internal medicine-T(.16)	Occupational health(.31)	Ophthalmology(.56)	Pathology(1.05)
12		Neurology-T(14)	Psychiatry(.31)	General surgery(.55)	Neurology (1.05)
13		Dermatology-T(.14)		Internal medicine(.54)	Pediatrics (1.15)
14				Aerospace(.51)	Urology (1.20)
15		General surgery(.13)		Pediatrics(.50)	Radiology(1.35)
16		Pediatrics(.13)		Preventive (.45)	Orthopedics(1.35)
17		Family practice (.13)		Psychiatry(.44)	Ophthalmology(1.40)
18		Thoracic surgery (.11)		Pathology(.44)	Thoracic surgery(1.40)
19		Pathology(.11)		Neurology(.42)	Infectious disease(1.45)
20		Preventive medicine(.10)		Cardiology(.35)	OB/GYN(1.45)
21		Psychiatry(.10)		Thoracic surgery(.27)	Plastic surgery(1.45)
22		Occupational health(.09)		Internal medicine(.26)	Allergy/Immunology(1.50)
23		Colon & rectal surgery(.08)			General surgery(1.50)
24		Aerospace medicine(.05)			Endocrinology(1.90)
25					Neurosurgery(1.90)

a. No other differences in attrition rates besides anesthesiology and family practice were statistically significant.
b. "-T" indicates that this program is tied statistically with those specialties listed above it.

Appendix D: Specialties sorted by predicted MOSR shortfall, default scenario

Table 22. Specialties sorted by predicted MOSR shortfall, default scenario, end FY 2010[a]

Specialty	Fully trained physicians, 2010	Duty tours, 2010	MOSR requirements	1994 authori-zations	Delta from MOSR	Delta from authori-zations
Emergency medicine	43	0	113	71	-70	-28
General surgery	125	0	191	150	-66	-25
Anesthesiology	139	0	199	142	-60	-3
Flight surgery—(aviation medicine)	175	27	254	295	-52	-93
Family practice	219	0	262	257	-43	-38
Preventive medicine	6	0	26	28	-20	-22
Psychiatry	58	0	76	96	-18	-38
Aerospace medicine	13	0	29	39	-16	-26
Undersea medicine	58	11	80	94	-11	-25
Colon and rectal surgery	5	0	8	9	-3	-4
Pediatrics	58	0	60	103	-2	-45
Plastic surgery	6	0	8	8	-2	-2
Dermatology	20	0	21	37	-1	-17
Pediatric otolaryngology	0	0	0	3	0	-3
Neuropathologyy	0	0	0	3	0	-3
Immunopathology	0	0	0	1	0	-1
Family practice obstetrics	0	0	0	0	0	0
Gynecologic pathology	0	0	0	0	0	0
Health management	0	0	0	0	0	0
Interventional cardiology	0	0	0	0	0	0
Pediatric oncology	0	0	0	0	0	0
Perinatal biology	0	0	0	0	0	0
Anesthesiology critical care	1	0	0	35	1	-34
Pediatric, critical care	1	0	0	6	1	-5
Pediatric, endo/met	1	0	0	3	1	-2
Peripheral vascular surgery	1	0	0	8	1	-7

Table 22. Specialties sorted by predicted MOSR shortfall, default scenario, end FY 2010[a] (continued)

Specialty	Fully trained physicians, 2010	Duty tours, 2010	MOSR requirements	1994 authori-zations	Delta from MOSR	Delta from authori-zations
Child neurology	1	0	0	5	1	-4
Cytopathology	1	0	0	3	1	-2
Neuroophthalmology	1	0	0	2	1	-1
Retinal surgery	1	0	0	2	1	-1
Cardiovascular electrophys	1	0	0	0	1	1
Neurophysiology	1	0	0	0	1	1
Neurology-critical care	2	0	0	35	2	-33
Pediatric gastroenterology	2	0	0	3	2	-1
Hand surgery	2	0	0	9	2	-7
Interventional radiology	2	0	0	5	2	-3
Pediatric radiology	2	0	0	4	2	-2
Rheumatology	2	0	0	4	2	-2
Urologic oncology	2	0	0	4	2	-2
Otolaryngology, F&R surgery	2	0	0	3	2	-1
Glaucoma	2	0	0	2	2	0
Hyperbaric medicine	2	0	0	2	2	0
Oculoplastics	2	0	0	2	2	0
Ophthalmology C&E disease	2	0	0	2	2	0
Ophthalmologic pathology	2	0	0	2	2	0
Other	2	0	0	0	2	2
Internal medicine, critical care	3	0	0	35	3	-32
Surgical critical care	3	0	0	35	3	-32
Pediatric cardiology	3	0	0	4	3	-1
Pediatrics, infectious disease	3	0	0	3	3	0
Pediatric pulmonary disease	3	0	0	4	3	-1
Internal medicine, endocrinology, diabetes	3	0	0	10	3	-7
Pediatric nephrology	3	0	0	3	3	0
Imaging radiology	3	0	0	9	3	-6
Maternal/fetal medicine	3	0	0	8	3	-5
Forensic pathology	3	0	0	7	3	-4
Developmental pediatrics	3	0	0	6	3	-3
Dermatopathology	3	0	0	5	3	-2
Gerontology	3	0	0	5	3	-2
Neuroradiology	3	0	0	5	3	-2

Table 22. Specialties sorted by predicted MOSR shortfall, default scenario, end FY 2010[a] (continued)

Specialty	Fully trained physicians, 2010	Duty tours, 2010	MOSR requirements	1994 authorizations	Delta from MOSR	Delta from authorizations
Pediatric surgery	3	0	0	4	3	-1
Pediatric urology	3	0	0	4	3	-1
Surgical oncology	3	0	0	4	3	-1
Otology	3	0	0	3	3	0
Strabismology	3	0	0	2	3	1
Sports medicine	3	0	0	0	3	3
Urology	36	0	33	32	3	4
Neurosurgery	24	0	21	18	3	6
Pediatrics, adolescent medicine	4	0	0	11	4	-7
Internal medicine	113	0	109	119	4	-6
Allergy and immunology	4	0	0	5	4	-1
Pathology-dermatopathology	4	0	0	5	4	-1
Reproductive endocrinology	4	0	0	4	4	0
Total joint surgery	4	0	0	3	4	1
Tropical medicine	4	0	0	2	4	2
Internal medicine, infectious disease	5	0	0	29	5	-24
Nuclear medicine	5	0	0	9	5	-4
Thoracic surgery	13	0	8	16	5	-3
Hematopathology	5	0	0	4	5	1
Physical medicine and rehabilitation	5	0	0	3	5	2
Pediatric hematology/oncology	5	0	0	4	5	1
Ophthalmology	25	0	19	38	6	-13
Internal medicine, nephrology	6	0	0	10	6	-4
Neurology	21	0	15	24	6	-3
Therapeudic radiology	6	0	0	9	6	-3
Pediatric orthopedics	6	0	0	6	6	0
Spine surgery	6	0	0	6	6	0
Child psychiatry	7	0	0	12	7	-5
Gynecologic oncology	7	0	0	8	7	-1
Neonatology	7	0	0	8	7	-1
Family practice faculty development	7	0	0	4	7	3
Occupational health	20	0	10	30	10	-10
Internal medicine, hematology, oncology	11	0	0	16	11	-5
Internal medicine, gastroenterology	12	0	0	23	12	-11

Table 22. Specialties sorted by predicted MOSR shortfall, default scenario, end FY 2010[a] (continued)

Specialty	Fully trained physicians, 2010	Duty tours, 2010	MOSR requirements	1994 authorizations	Delta from MOSR	Delta from authorizations
Internal medicine, pulmonary disease	12	0	0	20	12	-8
Family practice adolescent medicine	13	0	0	5	13	8
Anatomy/clinical pathology	52	0	30	68	22	-16
Internal medicine, cardiology	22	0	0	34	22	-12
Orthopedic surgery	172	0	143	105	29	67
ENT/ head & neck surgery	65	0	29	41	36	24
Diagnostic radiology	86	0	47	81	39	5
Obstetrics/gynecology	168	0	79	111	89	57
General medical officer	375	119	297	448	197	46

a. Numbers for flight surgery and general medical officers (GMOs) are highly affected by processes not modeled. The number of flight surgeons is influenced by transfers from other specialties, so their numbers will actually be larger than shown here. The GMO number shown here is inflated because it includes physicians who have finished an operational tour, have decided to finish their obligation, and will possibly seek residency training after leaving the Navy.

Appendix E: Specialties sorted by predicted MOSR shortfall, scenario 2 (1980s attrition)

Table 23. Specialties by predicted MOSR shortfall, scenario 2 (1980s retention rates)[a]

Specialty	Fully trained physicians, 2010	Duty tours, 2010	MOSR requirements	1994 authori-zations	Delta from MOSR	Delta from authori-zations
Family practice	175	0	262	257	-87	-82
Anesthesiology	113	0	199	142	-86	-29
General surgery	112	0	191	150	-79	-38
Emergency medicine	43	0	113	71	-70	-28
Flight surgery—(aviation medicine)	169	27	254	295	-58	-99
Psychiatry	44	0	76	96	-32	-52
Pediatrics	40	0	60	103	-20	-63
Preventive medicine	6	0	26	28	-20	-22
Undersea medicine	51	11	80	94	-18	-32
Aerospace medicine	13	0	29	39	-16	-26
Internal medicine	94	0	109	119	-15	-25
Orthopedic surgery	137	0	143	105	-6	32
Colon and rectal surgery	3	0	8	9	-5	-6
Plastic surgery	5	0	8	8	-3	-3
Dermatology	21	0	21	37	0	-16
Interventional radiology	0	0	0	5	0	-5
Pediatric otolaryngology	0	0	0	3	0	-3
Neuropathology	0	0	0	3	0	-3
Oculoplastics	0	0	0	2	0	-2
Immunopathology	0	0	0	1	0	-1
Family practice obstetrics	0	0	0	0	0	0
Gynecologic pathology	0	0	0	0	0	0
Health management	0	0	0	0	0	0
Interventional cardiology	0	0	0	0	0	0
Pediatric oncology	0	0	0	0	0	0

Table 23. Specialties by predicted MOSR shortfall, scenario 2 (1980s retention rates)[a] (continued)

Specialty	Fully trained physicians, 2010	Duty tours, 2010	MOSR requirements	1994 authorizations	Delta from MOSR	Delta from authorizations
Perinatal biology	0	0	0	0	0	0
Anesthesiology critical care	1	0	0	35	1	-34
Surgical critical care	1	0	0	35	1	-34
Pediatric, critical care	1	0	0	6	1	-5
Pediatrics, infectious disease	1	0	0	3	1	-2
Internal med, endocrinology, diabetes	1	0	0	10	1	-9
Pediatric nephrology	1	0	0	3	1	-2
Pediatric, endo/met	1	0	0	3	1	-2
Peripheral vascular surgery	1	0	0	8	1	-7
Child neurology	1	0	0	5	1	-4
Dermatopathology	1	0	0	5	1	-4
Gerontology	1	0	0	5	1	-4
Cytopathology	1	0	0	3	1	-2
Otolaryngology, F&R surgery	1	0	0	3	1	-2
Otology	1	0	0	3	1	-2
Neuroophthalmology	1	0	0	2	1	-1
Retinal surgery	1	0	0	2	1	-1
Strabismology	1	0	0	2	1	-1
Cardiovascular electrophys	1	0	0	0	1	1
Neurophysiology	1	0	0	0	1	1
Sports medicine	1	0	0	0	1	1
Internal medicine, critical care	2	0	0	35	2	-33
Neurology-critical care	2	0	0	35	2	-33
Pediatric gastroenterology	2	0	0	23	2	-21
Imaging radiology	2	0	0	9	2	-7
Developmental pediatrics	2	0	0	6	2	-4
Pediatric radiology	2	0	0	4	2	-2
Pediatric urology	2	0	0	4	2	-2
Reproductive endocrinology	2	0	0	4	2	-2
Rheumatology	2	0	0	4	2	-2
Urologic oncology	2	0	0	4	2	-2
Glaucoma	2	0	0	2	2	0
Hyperbaric medicine	2	0	0	2	2	0
Ophthalmology C&E disease	2	0	0	2	2	0
Ophthalmologic pathology	2	0	0	2	2	0

Table 23. Specialties by predicted MOSR shortfall, scenario 2 (1980s retention rates)[a] (continued)

Specialty	Fully trained physicians, 2010	Duty tours, 2010	MOSR requirements	1994 authorizations	Delta from MOSR	Delta from authorizations
Tropical medicine	2	0	0	2	2	0
Neurosurgery	23	0	21	18	2	5
Pediatric cardiology	3	0	0	4	3	-1
Pediatric pulmonary disease/ pulmonology	3	0	0	4	3	-1
Ophthalmology	22	0	19	38	3	-16
Pediatrics, adolescent medicine	3	0	0	11	3	-8
Hand surgery	3	0	0	9	3	-6
Maternal/fetal medicine	3	0	0	8	3	-5
Forensic pathology	3	0	0	7	3	-4
Allergy and Immunology	3	0	0	5	3	-2
Hematopathology	3	0	0	4	3	-1
Pediatric surgery	3	0	0	4	3	-1
Surgical oncology	3	0	0	4	3	-1
Physical medicine and rehabilitation	3	0	0	3	3	0
Urology	36	0	33	32	3	4
Nuclear medicine	4	0	0	9	4	-5
Pediatric orthopedics	4	0	0	6	4	-2
Neuroradiology	4	0	0	5	4	-1
Pathology-dermatopathology	4	0	0	5	4	-1
Total Joint surgery	4	0	0	3	4	1
Pediatric hematology/oncology	4	0	0	0	4	4
Internal medicine, infectious disease	5	0	0	29	5	-24
Occupational health	15	0	10	30	5	-15
Neurology	20	0	15	24	5	-4
Spine surgery	5	0	0	6	5	-1
Family practice faculty development	5	0	0	4	5	1
Internal medicine, nephrology	6	0	0	10	6	-4
Gynecologic oncology	6	0	0	8	6	-2
Thoracic surgery	14	0	8	16	6	-2
Child psychiatry	7	0	0	12	7	-5
Therapeudic radiology	7	0	0	9	7	-2
Neonatology	7	0	0	8	7	-1
Internal medicine, hematology, oncology	10	0	0	16	10	-6

Table 23. Specialties by predicted MOSR shortfall, scenario 2 (1980s retention rates)[a] (continued)

Specialty	Fully trained physicians, 2010	Duty tours, 2010	MOSR requirements	1994 authorizations	Delta from MOSR	Delta from authorizations
Family practice adolescent medicine	11	0	0	16	11	-5
Internal medicine, pulmonary disease	12	0	0	20	12	-8
Internal medicine, gastroenterology	13	0	0	23	13	-10
ENT/ head and neck surgery	46	0	29	41	17	5
Anatomy/clinical pathology	50	0	30	68	20	-18
Internal medicine, cardiology	22	0	0	34	22	-12
Diagnostic radiology	75	0	47	81	28	-6
Obstetrics/gynecology	152	0	79	111	73	41
General medical officer	373	119	297	448	195	44
Other	0	0	0	0	0	0

a. Numbers for flight surgery and general medical officers (GMOs) are highly affected by processes not modeled. The number of flight surgeons is influenced by transfers from other specialties, so their numbers will actually be larger than shown here. The GMO number shown here is inflated because it includes physicians who have finished an operational tour, have decided to finish their obligation, and will possibly seek residency training after leaving the Navy.

References

[1] Thomas J. Whelan. "Why Residency Programs in the Military? The Impact of History and Influencing Forces." *Military Medicine* 139 (4), Apr 1974: 265–272

[2] F. Ledford and T. Driskill. "The Army Graduate Medical Education Program." *Military Medicine* 12, 1976: 837–843

[3] Committee of the Institute of Medicine. *Graduate Medical Education and Military Medicine.* Washington, DC: National Academy Press, 1981

[4] Society of Medical Consultants to the Armed Forces. "Military Graduate Medical Education Under Stress: A White Paper," Oct 1987

[5] Donald R. Custis. "GME Essential for Military Medicine's Health." *U.S. Medicine,* Dec 1994: 4

[6] Office of the Assistant Secretary of Defense, Program Analysis and Evaluation. *Physician Retention and the Cost-Effectiveness of the Uniformed Services University of the Health Sciences,* Jul 1991

[7] Office of the Assistant Secretary of Defense, Health Affairs. *The Cost of Physician Accessions,* Jan 1988

[8] Health & Sciences International, Incorporated, Lewin/ICF. *Study of the Economic Impact of Legislated Limits on Resident Work Hours in California,* Feb 1990 (Final Report, State of California Contract #63SA8010-P8)

[9] Kenneth E. Thorpe. "House Staff Supervision and Working Hours: Implications of Regulatory Change in New York State." *Journal of the American Medical Association* 263 (23): 3177–3181

[10] Laurie May, Amy Graham, and Michelle Dolfini. *Medical Manpower Shortages and the Retention of Navy Physicians,* Mar 1989 (CNA Research Memorandum 88-231)

[11] Joyce McMahon et al. *Pay and the Retention of Navy Physicians,* May 1989 (CNA Research Memorandum 88-266)

[12] Joyce McMahon. *Evaluation of the FY 1990 Medical Officer Retention Bonus,* May 1992 (CNA Research Memorandum 91-247)

[13] Amy Graham and Laurie May. *Retention of Navy Physicians, FY 1984–1988,* Jun 1989 (CNA Research Memorandum 89-33)

[14] "Military GME Reductions Outlined." *U.S. Medicine,* Apr 1994: 1–7

[15] "Joint Residencies: Practice Changes." *U.S. Medicine,* Jul 1995: 1, 26, 27

[16] "Medical Cuts Won't Be by Scalpel." *Navy Times,* 6 Feb 1995

[17] Timothy H. Weber. "The THCSRR Model: Determining Navy Medicine's Readiness Manpower Requirements." *Navy Medicine,* Sep–Oct 1994: 19–22

[18] Robert Levy and Neil Carey. *Measuring the Impact of the Navy's Downsizing on Medical Officer Billets,* Mar 1994 (CNA Research Memorandum 93-217)

[19] Navy Bureau of Medicine and Surgery. *October 1994 Medical Department Officer Personnel Report* (MED-512)

[20] Navy Bureau of Medicine and Surgery. *Medical Corps Specialty End Strength Projections "World-Book," Billet Data as of 31 Dec 94, Strength Data as of 31 Jan 95*

[21] U.S. Department of Defense. "Minimum Terms of Service and Active Duty Obligations for Health Services Officers," 8 Apr 1988 (DOD Directive No. 6000.2)

[22] Amy Graham. *Defining Initial Obligation for Navy Physicians,* Feb 1989 (CNA Research Memorandum 88-229)

[23] David Rodney. *A Community Simulation Model for Surface Warfare Officers (COSMOS),* Sep 1992 (CNA Research Memorandum 92-81)

[24] Neil Carey. *Savings and Costs From Using the "Air Force Model" of Graduate Medical Education (GME),* Mar 1995 (CNA Research Memorandum 95-44)

[25] Robert D. Mason. *Statistical Techniques in Business and Economics.* 4th ed. Homewood, IL: Richard D. Irwin, Inc., 1978

[26] William Marder et al. *Physician Supply and Utilization by Specialty: Trends and Projections.* Chicago: American Medical Association, 1988

[27] B. Jerald McClendon (Director, Office of Research and Planning, BHPr/HRSA). *How Many Physicians Are Required? Briefing for Dr. Sumaya,* Sep 1994

[28] U.S. Department of Health and Human Services. *Council on Graduate Medical Education Sixth Report on Managed Health Care: Implications for the Physician Workforce and Medical Education,* Sep 1995

[29] Harvey M. Wagner. *Principles of Operations Research With Applications to Managerial Decisions.* Englewood Cliffs, NY: Prentice-Hall, Inc., 1969

[30] American Medical Association. *Graduate Medical Education Directory, 1994–1995.* Chicago: American Medical Association, 1994

List of tables

Distribution list
Research Memorandum 95-209

SNDL

24D1 COMNAVSURFLANT NORFOLK VA
Attn: CAPT. J. FAHEY

A5 CHBUMED
Attn: SURGEON GENERAL
Attn: DEPUTY SURGEON GENERAL
Attn: RADM. J. JOHNSON, MED-08
Attn: RADM. F. SANFORD, MED-00MC
Attn: RADM J. ENGEL, MED-05
Attn: CAPT. K. ST ANDRE, MED-38
Attn: CDR V. RUBIN, MED-82
Attn: JOHN DURHAM, MED-81
Attn: CDR A. ROSSI-MARSH, MED-52
Attn: CAPT R. HUFSTADER, MED-00MCB
Attn: LT. T. DOWTY, MED-82
Attn: CAPT. P. GARST, MED-00MCB2
Attn: RADM. W. SNELL, MED-00DC
Attn: CAPT. G. GRAF, MED-00DCB
Attn: CAPT. C. GIBBIN, PERS 211M
Attn: CAPT. J. LABOW, NSHS-07
Attn: MED-02

OPNAV

N931
Attn: RADM. N. DYSART

N931C
Attn: CDR. D. SNYDER